COMPUTERS AND AUTOMATION

YBERNETICS • ROBOTS • AUTOMATIC CONTROL

Ready to Bind

Machines and Religion
. . . Elliot Gruenberg

Automatic Coding Techniques for Business Data Processing — Directions of Development
. . . Charles W. Adams, Bruse Moncreiff

What is a Computer?
. . . Neil D. Macdonald

Glossary of Terms and Expressions in Computers and Automation (cumulative)

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THE EDITOR'S NOTES

THE COMPUTER DIRECTORY, 1956

The June 1956 issue of "Computers and Automation" will be the second issue of "The Computer Directory". Last year we published the first issue, 164 pages. Our present plans for the June 1956 directory follow:

Part 1 of the directory in 1956 will be a cumulative "Roster of Organizations in the Computer Field" based on the last cumulative roster (published December 1955, containing about 330 entries) and brought up to date. Entries in this roster will be free. If you know of any changes, additions, or corrections which should be made in the entries, please tell us.

Part 2 of the directory will be the second edition of "The Computing Machinery Field: Products and Services for Sale." Over 600 entries on 21 pages appeared in the first edition in June 1955; a considerable increase is anticipated. The previous entries, and blank forms, will be sent in February, to suppliers for review, checking, and additions. It is expected at this time that a nominal charge of $6.00 an entry will be requested from each supplier in order to help defray the cost of preparing and printing the directory; but if the charge is not paid, the entry may still appear in condensed form, if desirable to make the listing complete.

Part 3 of the directory will be the third edition of the Who's Who in the Computer Field. In the June 1955 issue, about 7500 entries appeared on 96 pages; of these about 2600 were full entries, and the remainder were brief entries. Our present plans are to publish only new or revised Who's Who information in the June 1956 directory. Blank forms for new or revised entries will be sent in February or March to all computer people we know of. It is expected at this time that a nominal charge of $2.00 an entry will be requested from each person whose entry is printed, in order to help defray the cost of preparing and printing the Who's Who; but if the charge is not paid, a brief entry may appear in condensed form if desirable to make the listing complete.

The main reason for the nominal charges mentioned above is that we look on the directory as a service to many people in the computer field; yet so far it has not paid for itself; and we need to make a compromise, publishing at least some information about everything that should appear in the directory, but fuller information for those who have shared directly in the cost.

Any comments or suggestions about "The Computer Directory, 1956", and our plans for it will be welcome.

GLOSSARY

In this issue we print another "Glossary of Terms and Expressions in the Field of Computers and Automation", containing over 420 terms. Here is another piece of reference information where we think we should now invite colleagues: are there any volunteers to help the editors conduct the glossary? As previously, no attempt is being made to establish by decree the meaning or usage of a term: we desire simply to report meanings and usages.

CORRECTION

In the December 1955 issue, on page 44, on the first line, the word "AND" should appear between "COMPUTERS" and "AUTOMATION". Please enter the change on your copy of the magazine.

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MACHINES AND RELIGION

ELLIOT GRUENBERG
New York, N. Y.

The topic of machines and religion may seem to some readers incongruous. What connection could exist between machines and religion?

There is the story of a convention called to discuss the subject of elephants, to which were invited an Englishman, a Frenchman, a German and a Pole. They were all asked to submit papers on the topic. The Englishman responded with "The Jolly Sport of Hunting Elephants"; the German, with "The Weltanschauung of the Elephant"; the Frenchman, with "The Sex Life of Elephants", and the Pole with "THE ELEPHANT AND THE POLISH QUESTION".

In raising the question of a connection between machines and religion, am I putting myself in the same position as the Pole?

If we regard religion as a frame of reference used to help pattern our way of life, then we shall find that machines have and will exert an influence upon religion; for machines have changed and will change our mode of existence, our values, our objectives and our feelings. Our outlook on life today no longer can be that of a 13th century serf or a pre-Revolutionary farmer.

Machines are assuming an increasingly important role in our lives and one as perplexing as it is important. Anxiety persists about the competitive aspect of the function of machines with regard to the livelihood of men. Much has been said about the beneficial aspects of machines with respect to drudgery. It is often maintained that the long-run effect of the Industrial Revolution has been both to increase (rather than diminish) the opportunity for work and to raise the standard of living. I, for one, am willing to accept this thesis. Just one fact may be convincing with regard to the economic effect of mechanizing. In 1929, a most prosperous year, Salaries and Wages were 59% of Gross National Product. In the last several years, after years of making processes more automatic, this figure has been running between 61% and 68%. 68% is the figure for this year. In the intervening 25 years salaries and wages were never below 61% of the GNP, and 65% is a good average for the period. Before World War I, the average figure was never above 60%. The share in the total economy of the salaried class has increased by nearly 10 percentage points. Yet the working force has remained fairly steadily at 40% of the total population. The most recent economic effect of mechanizing seems to have been to increase the working man's share of the economy by a substantial amount, although it is evident that he has had to increase his skillfulness to do this.

Yet the anxiety persists. Perhaps its source is not in the economic issues, but elsewhere. These other possible sources of the worry ought to be worth exploring.

The concept of work, it seems to me, lies at the root of the problem. The idea of the Godliness of work was one of the pillars of the Protestant Reformation. The reformation preceded by a century or two the Industrial Revolution and may very well have been a cause of it. To this day we hear this idea echoed. Former President Truman, for example, in a recent TV appearance on Ed Murrow's "Person to Person", said he believed work never killed anyone and attributed his success to hard work. But what is meant by work? muscular activity? or remaining in one place and keeping an eye on things? or doing what you are paid to do? or solving mental conundrums? or searching among tomes in an ecclesiastical library?

When Yehudi Menuhin was 18 years old, back in 1935, he made this statement: "Someday, maybe not in my lifetime, but someday, people will live in a world where machines take the monotony out of life. There will be no stupid tasks such as driving taxicabs, working in mines, doing any sort of thing because of the necessity of existing.....Above all, there must be education -- education in how to employ leisure time in a world which will offer mostly leisure hours.....Life would not be so terrible if it wasn't forced. It is not fair that any human being should be forced to work set hours, day after day. If such a system marks civilization, it would be better to return to the wild life."

But is not playing the violin just as much work as driving a taxi? Surely hours of repetitious training must go into violin concert work, no matter how great the gift of genius. The machine has at very least cast the shadow of doubt upon older concepts of work. The machine compels us to use terms to distinguish the work we like from the work we don't like. Many like the idea of creative work. Surely machines cannot do this. And isn't violin

playing creative? Unfortunately, a machine is being developed by RCA which can synthesize almost any known sound. Digital computers can be programmed so as to play the synthesis directly from the musical score. I am an admirer of Mr. Menuhin's artistry, but I am reasonably sure that his work could more readily be duplicated mechanically than can the "stupid" work of a taxi driver, particularly in a New York City traffic jam. Perhaps some of the golden tone and the mature insight will be missing from the mechanical rendition, but the machine could do a workmanlike job.

And yet owners of taxi fleets are reported to be harassed by a high turnover rate among drivers. Cab drivers don't think they have prestige. So the owners have hired a psychologist to find an ego-building formula. Perhaps he would find help from some of these remarks.

The exciting profile about Yehudi Menuhin written by Winthrop Sargeant, which appeared in recent issues of the New Yorker, is very revealing on the question of artistic control. Just what are the interactions between the musician's mind, his instrument and his body? The whole of a violinist's training is directed toward giving him a dependable pattern of muscular habits. These, in time, become so automatic that his mind is freed for the more difficult artistic problems. But these also become solved more and more automatically. Indeed, many artists entrust their entire performance to their automatic habits. There are some virtuosi who maintain conscious control but greatness as an artist is by no means a function of the degree of such control. Indeed, Yehudi Menuhin's playing as a child seemed to be as instictive as a bird's singing. Yet the innocent purity of his playing as a child has not been surpassed by his work as a mature artist, when a fully developed, educated mind could take control. The message here seems to be that a virtuoso becomes better as he becomes more automatic in his work. The child can surpass the man; perhaps the machine can surpass the child.

It would be well to recall, at this point, the player piano. It is not completely extinct. The modern digital computer resembles, to a very large extent, this product of an earlier ingenuity. The computer's equivalent of the music roll is magnetic tape, which can be operated at high speed and can be erased or changed. In addition, orders and information can be stored in a memory section of the computer for use in later operations. This last cannot be done in the player piano. For this reason, the modern computer can do many more things, but it still cannot cope with all the unexpected events a taxi driver has to face.

The work of the virtuoso is thus open to doubt as being creative. So it is not inviolate to the machine menace. Some will argue, however, that a composer is truly creative. How much of this work is in the nature of a search in an area where there might be ideas? Or combining possibilities and rejecting poor ones? Does it not resemble the Uranium hunter with his Geiger counter looking for "hot" ore? How much real control over this process does the artist have? Is it more than the mother has over the form of her unborn child? Surely there are times when one must wait, as I have waited, until inspiration comes, until unconscious thoughts blend and innovation rolls off the wheel of experience. The seeds must be planted or there will be no harvest, but we must wait for the tree to grow, and there is precious little we can do to speed its progress. If results are not forthcoming, we must plant more seeds.

There is this celebrated passage in Gulliver's Travels to Balnibarbi:

> "The Professor then led me to the frame about the sides of which all his pupils stood in ranks. It was twenty feet square, placed in the middle of the room. The superficies was composed of several bits of wood about the bigness of a die, but some larger than others. They were all linked together by slender wires. These bits of wood were covered on every square with paper pasted on them and on these papers were written all the words of their language in their several moods, tenses and declensions, but without any order. The Professor then desired me to observe for he was going to set his engine at work. The pupils, at his command, took each of them hold of an iron handle, whereof there were forty fixed round the edges of the frame and, giving them a sudden turn, the whole disposition of the words was entirely changed. He then commanded six and thirty of the lads to read the several lines softly as they appeared upon the frame; and, when they found three or four words together that made part of a sentence, they dictated to the four remaining boys who were scribes. This work was repeated three or four times and at every turn the engine was so contrived that the words shifted into new places as the square bits of wood moved upside down.
>
> Six hours a day the young students were employed in this labor and the Professor showed me several volumes in large folio already collected of broken sentences which he intended to piece together and out of those rich materials, to give the world a complete body of all the arts and sciences."

I suppose I should not have introduced the thought in so derisive a fashion, but

Swift's caricature of the laws of statistics and probability still is a good idea of much of the so-called creative process. The true genius makes his selections faster -- astoundingly faster -- than blind chance, but if the field of interest be narrow enough, machines can make choices too.

All of this leads to the conclusion that most endeavors regarded as work by men can be taken over by mechanical means...creative work or drudgery, watching or composing, building or copying, violin playing or, eventually, taxi driving. Such functions may not be economical to mechanize now, but this may change with the years, the press of population, and scientific research. But is this eventuality to be feared or welcomed? What tasks should man reserve for himself?

Man, in the final analysis, ought to work at those endeavors which allow him to express himself -- his "humankindness". Whatever is the essence of man should be enhanced by his activity. Is mere survival sufficient reason for his existence? Or is there more implied in his constant yearning and aspiring to improved ways of doing things, to better insight, toward a finer maturing and toward a better understanding?

Aristotle, in his search for the unique essence of man, concluded that his distinguishing mark was his possession of reason and his being capable of living by reason. Happiness is to be found in pursuing this unique activity. Thus, if work is not to be the exclusive domain of man, then it might be reason. A territory was thus staked out for man some 2500 years ago by one of the world's most profound teachers. Evidence is starting to appear, however, to show that the power to take rational action is not the exclusive feature of man, but certain animals and insects can do so too. Notably, bees communicate with each other, and direct other bees to sources of food by certain dances. They also practice division of labor. A certain spider masquerades in the shell of an ant to prevent being eaten. It seems that spiders are delectable to too many foes, whereas ants are not.

Someone has advanced this argument against the intelligence of dogs: "If they can think, why don't they say so?" Dogs may be smart. It has been said that it is better to remain silent so others cannot be sure one is stupid, than to open one's mouth and remove all doubt.

The modern development of the Industrial Revolution largely named "Automation" is mainly an improvement in the art of control. The Industrial Revolution started with the application of energy to work, and the energy depended upon human or animal power. The emphasis now is upon ways and means of controlling this power to a particular end. Control is an activity which is inevitably associated with reason and thinking. The objective of the control and process must be defined. Once this is done, computers may be used to make regulations in the process and decisions about it, based upon events that are currently occurring. The versatility of this decision-making and process-correcting is becoming greater at a steeply climbing rate. Within limits, these new machines are doing things which Aristotle might concede are rational. Indeed, if a modern Rip Van Winkle, who missed the innovations of the past 25 years, were to awake today, he would swear that he was seeing miracles. We do not so regard them, however, because we are continually and gradually adapting to them. But if the machines are making inroads upon man's apparently unique function of reason, is this enough to discredit Aristotle's implication that man's true role is to reason, to think, to contemplate?

Spinoza believed that man would achieve happiness by acting in his own self-interest. But to do so implies that he knows what that interest is. If he knew the rules governing his nature, he would act so as always to preserve himself, to fulfill himself. So little is known about human nature, even today, that we must still grope toward the goal of fulfillment, of maturity, of which we hear so much today. The unrational side of human nature has become well recognized in the last century. It is accepted that reason alone does not spell out the whole man. He needs to love and to work, as well as to think.

The great religions have been based on one view or another as to the true nature of man. In one, man is an expression of an impersonal life force; in another, he is a servant of God; in still another, his true role is in another world. How can we say categorically, where man and machine fit into the scheme of things, when so much uncertainty exists as regards man's nature? We can only say that the development of the machine challenges our concepts of man's nature, makes us recast our ideas, our preconceived notions and makes us look out on life with different eyes. And this view reflects back into us and makes us look upon ourselves in a different light.

The Faust legend, which has entwined itself so much into the literature of Western Europe, is essentially a story concerned with this very question: "What is man's true role?" Shaw became interested in this legend and this resulted in the famous extra act of "Man and Superman", which is known so well as "Don Juan in Hell". I would like to paraphrase here a few lines of this work, because of the insight it appears to offer on the question of man's

true role. It is not offered as a final answer, but only as some more or less shrewd guesses.

Shaw has Don Juan, a symbol of the spirit of man, expound on the differences of Heaven, Hell and Earth. Hell, he says, is the "Home of the unreal and the seekers for happiness. Heaven is the home of the masters of reality and earth is the home of the slaves of reality." The earth is a nursery in which "men and women play at being heroes and heroines, but are dragged down from their fool's paradise by their bodies, hunger and cold and thirst, age and decay and disease. Death, above all, makes them <u>slaves of reality</u>." Heaven, then, is an escape of the fetters of the body, but, "In Heaven you live and <u>work</u>, instead of playing and pretending." There Don Juan can go to escape from lies and spend his eons in contemplation... Contemplation of Life, the force that ever strives to attain greater power of contemplating itself. "What makes this brain of mine, do you think? Not the need to move my limbs, for a rat with half my brains moves as well as I. Not merely the need to do, but the need to know what I do, lest in my blind efforts to live, I should be slaying myself."

"What a piece of work is man....the most conscious of organisms, yet how wretched are his brains. Stupidity made sordid and cruel by the realities learnt from toil and poverty. Imagination resolved to starve sooner than face these realities, piling up illusions to hide them and calling itself cleverness, genius."

The Devil pounces upon this and says, "All Man's reason has done for him is to make him beastlier than any beast." Don Juan protests and points out that brainless bodies have been tried, such as some of the dinosaurs, which paced the earth with seven league steps, but for lack of brains, they did not know how to carry out their purpose and so destroyed themselves.

"But", says the Devil, "Is Man any the less destroying himself for all this boasted brain of his? I have examined Man's wonderful inventions and I tell you that in the arts of <u>life</u>, Man invents nothing, but in the arts of death, he outdoes Nature herself and produces by chemistry and machinery, all the slaughter of plague, pestilence and famine."

"The inner need that has nerved Life to the effort of organizing itself into the human being is not the need for the higher life, but for a more efficient engine of destruction. Something more constantly, more ruthlessly, more ingeniously destructive was needed and that something was Man, the inventor of the Rack, the stake, the gallows, of sword and gun and poison gas; above all, of justice, duty and patriotism and all the other isms by which even those who are clever enough to be humanly disposed, are persuaded to become the most destructive of all the destroyers."

"But", says Don Juan, "You are making the mistake of taking Man at his own valuation. He loves to think of himself as bold and bad. He is neither one nor the other. He is only a coward. Call him tyrant, murderer, pirate, bully and he will adore you. But call him coward, and he will go mad with rage; he will face death to outface that stinging truth. Man gives every reason for his conduct save one; every plea for his safety save one; and that one is his cowardice. Yet all his civilization is founded on his cowardice, on his abject tameness, which he calls his respectability."

"Precisely", cries the Devil, "And these are the creatures in whom you discover the Life Force?"

"Yes," says Don Juan, "For now comes the surprising part of the whole business."

"And what is that?"

"Why," says Don Juan,"that you can make any of these cowards brave by simply putting an idea into his head."

Give a man an idea. Yes, this is what man needs. He needs to live for ideas which transcend him. This is why he wants work. He wants to <u>master</u> reality, rather than be enslaved by it. This is the direction of his striving. He does not want play, but work, the kind of work that is so all-absorbing that he forgets time and space.

In this work, he needs a brain to know what he does so that he does not slay himself. Less will man be relied upon to turn the screw, to press the lever on the drill press, to fashion by himself the chairs, automobiles and other furniture of living. But more will he be relied upon to decide what should be done and why it should be done.

This is the work of management, as we regard it today. But it is inherent in every task. The trend to automation today is emphasizing this work of man as objective-giver.

The productive capacity today is so enormous that decisions have to be made as to <u>how much</u> should be made. This decision is characteristic of an age of plenty. While such an eventuality is not yet an actuality, still the approach to it has had sociological consequences. Riesman points to the emergence of the "other-directed" man, the man who tends to look to others in the crowd for signals that he is accepted and, hence, looks to them for

(continued on page 45)

Automatic Coding Techniques for Business Data Processing — Directions of Development

CHARLES W. ADAMS, Pittsburgh, Pa., and
BRUSE MONCREIFF, Santa Monica, Calif.

I. Letter to the Editor from Charles W. Adams

I recently conducted an informal survey of current opinion on what directions should be taken in the development of automatic coding techniques for business data processing. One of the replies I received was from an old friend of mine at The RAND Corporation, Bruse Moncreiff. Bruse, you will recall, has been involved in business data processing since the early investigations were conducted at Prudential Insurance Co.

His long, informal letter seems to me to combine interesting reading with a number of fine ideas and controversial opinions. Consequently, I have sought his permission to send it along to you in hopes you would want to share it with your many readers. In granting this permission, he wrote to me that "since my previous letter could not possibly have any serious value, I can only conclude that there must be an element of humor in it that I did not myself appreciate." He also indicated that his tentative flow chart for the Automatic Supervisor runs to 329 boxes, including connectors, that he has coded the routine for the 702, and that he hopes to present a paper on it, perhaps at the Western Joint Computer Conference.

II. Letter to Charles W. Adams from Bruse Moncreiff

My views on the whole subject of getting business procedures planned for automatic information handling equipment are, no doubt, needlessly philosophical and therefore obscure. It may help if the thesis is presented first, so that you can see what all the fuss is about: The hardest and most important part of this planning process is in the logic of the problem rather than in the coding. I'm sure you have heard this repeated, <u>ad nauseum</u>, but the illumination comes in the defense of the thesis rather than in its statement.

This defense should include such items as:

1. The equivalence of logic and mathematics.

2. The comparative simplicity of land measurement and astrophysics (compared to business operations).

3. The theoretical difficulties in those parts of logic beyond the calculus of propositions and the simple theory of classes.

4. The unfortunate and accidental early connection of commercial transactions with the accumulation of wealth, which led to the development of the theory of classes (arithmetic being a branch of the same) rather than to the development of the theory of relations.

5. The preoccupation of the remaining segment of humanity (those not clever enough to make money) with the simple aspects of experience, i.e. continuous processes rather than the more intellectually difficult ones, the discrete processes.

6. The neurotic tendency of humans to blame their troubles on causes over which they have no control, rather than on causes which can be influenced by some effort. (Hence the interest in astrology rather than in a calculus of social relations).

Well, we seem to be a long way from the point, but at least I have proved that my views are needlessly obscure. To sum up (apples plus oranges style), the logic of business operations is more complex than that of physical phenomena, and we are less well equipped with a standard notation and manipulative techniques in the commercial field than we are in the area of the natural sciences. We have several centuries of catching up to do -- and this is why I support the platitude that business operations are more complex than scientific computation.

In substance, what we need are methods of generating consistent and efficient logical designs for clerical and commercial control processes. A simple example to reinforce my point occurred in connection with a problem used in a recent coding class which I attended. In order to keep the students' attention fixed on the machine being taught, the problem was laid out in very detailed flow chart form. This flow chart had been used by several classes and had been revised three times. It covered four 8½ x 11 pages and took approximately 500 single address orders to code. The

more obnoxious members of the class detected four rather serious errors in logic, one of which would have prevented the problem from running at all. The other errors were either questions of efficiency or of achieving the results desired. On the other hand, the less experienced members of the class were able to follow the flow chart and write code with practically no trouble. What does this example prove? Nothing perhaps, but it does lend some evidence to the belief that experienced people have more trouble with the logic of a problem than even inexperienced people do with coding. And of course the problem of determining what the machine is to do and what results are desired is another and sadder story.

Better send out for another box of Kleenex -- you'll need it after you read what I think about libraries of business routines. First of all, let's think about what motivates the "library" practice. This method is useful where there are operations, more complex than those built into the machine, which occur in several places in the same or similar form. Libraries save the effort required to think them through again and again. Fine! Let us look at the business situation, to see if the phrase "in several places" applies. This phrase may mean "in several places within the routines used by any one company." It may also mean "shared by many or all companies with large-scale automatic information handling equipment."

It has been argued that this latter interpretation cannot provide support for the "library" movement, since no two companies would ever agree to do things the same way. Just to be disagreeable, I find more merit in this interpretation as a possible motivation than I do for the other interpretation. For instance, it seems quite likely that there is one best method for handling production and inventory control, sales records and statistics, payroll, and general accounting for two manufacturers of 15/16" rubber gaskets for garden hoses -- provided, of course, that they were of approximately the same size and located in the same city (this latter condition imposed only to avoid any possible complication in different tax regulations). Inasmuch as our two hypothetical manufacturers are probably using the same type of sales slips and general ledger books (recommended by the consulting accountant retained by both firms) it seems quite probable that they could both be persuaded to use the routines very carefully worked out by the applications staff of the company where they obtained their identical equipments. No doubt you will be able to think of even more plausible instances where companies could share libraries of routines.

On the other hand, the notion that there are common subroutines scattered throughout the processes within a single company seems to me to have no merit at all. That there are common operations is obviously true, but these are the ones commonly wired into the machine by the designer. There is no standard notation for more complex operations in business than these arithmetic ones. In this case, to be recognized and named is to exist; or rather, not to be recognized nor named is not to exist. I agree that work in the area of library building has lagged rather badly, but disagree with the implication that something ought to be done about it right away. In fact, our energies should be centered, as they are today, in more productive areas.

Having disposed of libraries, we can also get along without the compilers required to put their routines together. On the other hand, there is a theoretical need for the true generators and converters -- there may even be economic justification for them. If this type of routine will give us more output in the way of useful structure than input, we should accept the gift with gratitude. Of this kind of thing, the sorting routine generators are of real, and, I hope, temporary value.

You can dry your eyes now for the last time, for I am about to dispel the gloom with a brief revelation of what is probably the sole worthwhile effort in the field of business data processing. Following the rule that we ought to mechanize first those aspects of the total situation which either cost the most or annoy us the most, I have turned my attention to the problem of the day-to-day operation of an automatic data processor. The things that annoy programmers most are operators, so I am attempting to all but program them out of existence. There are certain phases of an operator's work, mostly involving manual dexterity, which of necessity have been preserved. I have tried to remove all the thinking from his job, since this is what people do least efficiently. I like to think of this proposed routine as an automatic supervisor rather than operator since it will be telling the human operator what do so.

The actions of an operator may be thought of as either (1) the things he does while the machine is working, or (2) the things he does to get it working again after it has stopped in an error condition. While the second class may be more important from the standpoint of operating efficiency, the first class seemed more susceptible to analysis. So this is where I started. My early thinking was done with the 702 in mind. The items included in the philosophy of the automatic supervisor are:

(1) The storage of programs for specific jobs on tape.

(2) The loading of these programs accord-

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WHAT IS A COMPUTER?

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A manufacturer who has made and sold many good analog computers once said to us "I still don't know what a digital computer is". This made us stop to wonder if each reader of "Computers and Automation" could give a good answer to such questions as these:

What is a computer?
What is the difference between an analog and a digital computer?
How does a computer actually compute?

According to Geoffrey Ashe, in his article "Introducing Computers to Beginners" (in "Computers and Automation", March, 1954), some computer men, and perhaps many, can hardly explain the operation of a computer in simple language to people who are new to the field. Yet this is important. The field of computers and automation can grow rapidly only if simple yet correct explanations can be given easily.

A magazine, like a newspaper, may well compromise between publishing information which is news, and publishing information which is a summary of what has happened before. In this way people who have missed the earlier parts of a developing story are able to understand the whole story.

What is a Computer?

A computer is a person or machine that is able to take in information (problems and data), perform reasonable operations on the information, and put out answers. A computer is identified by the fact that it (or he) handles information reasonably.

For example, a human being aided by pencil and paper may be a computer. He may take in information, write some of it on the paper, perform reasonable operations upon the information, and come out with an answer. Likewise a machine may be able to take in information, record it in the arranging or positioning of some of the equipment inside the machine, perform reasonable operations upon that information, and come out with an answer. Both are computers.

This definition clearly depends on "reasonable operations". What does this mean?

Reasonable Operations

Reasonable operations are logical and mathematical operations. Mathematical operations include addition, subtraction, multiplication, division, taking square root, etc., and also more advanced mathematical operations such as raising to a power, finding the derivative, and integrating. Logical operations include comparing, selecting, sorting, matching, merging, determining the next instruction which is to be performed, etc. These are reasonable operations on information.

Reasonable operations are those operations which are correct logically or mathematically, and the definition of this brand of correctness can be accomplished by tables of accepted results. For example, correct multiplication can be defined in terms of the multiplication table and a few rules.

From the viewpoint of the fundamentals of logic and mathematics, reasonable operations on information have these properties: they do not question the objective meaning of the starting data; they do not question the factual truth of the starting statements; but they do find out the implications contained in these data and statements.

Consider the argument: "The moon is made of green cheese; anything made of green cheese is a weighty object; and therefore the moon is a weighty object". Here the argument is logically valid (or computable), and the conclusion is (accidentally) true, although both premises are false. A computer specializes in deriving conclusions (logical or mathematical) without regard to the objective truth of the starting data.

The fact that reasonable operations do not depend on the meaning of the information is what makes calculation fast. For instance, to add 111 and 444 and obtain 555 for the answer neither the person nor the machine has to remember the meaning of these numbers. In an appropriate kind of language, the operations can be carried on with the marks or symbols only. And then, to the everlasting wonder of nearly everybody, if the premises correspond with the real world, so do the conclusions.

What is Information?

Information is a set of marks that have meaning. Physically, the set of marks is a set of physical objects or a set of arrangements of some physical equipment. Then, out of this set, a selection is made in order to communicate, to convey meaning. For meaning to exist, there has to be a society of at least two persons or machines, a society that requires communication, that desires to convey meaning. By convention, the society establishes the meaning of the marks. The meaning exists independently of the particular kinds of marks that may be used; for example, "it is raining, il pleut, es regnet" all have the same meaning, although English, French, and German are the three kinds of sets of marks in which the meaning has been expressed.

The kinds of physical objects which can be used to express information are extremely varied. Many different kinds of equipment inside a machine may be used to record and manipulate information. In a desk calculating machine, information may be stored and manipulated in small counter wheels bearing geared teeth, and usually having ten positions corresponding to the digits 0, 1, 2 up to 9. In an automobile, a flexible cable running from a roller connected with one of the wheels to an indicator dial in the dashboard, records, by the amount and speed of its turning, the distance traveled by the automobile and its speed. In a great automatic electronic computer, such as the machine known as Univac, information may be recorded and manipulated as trains of minute electrical pulses which are millionths of a second apart; and the presence or the absence of a pulse in a position where either may occur is the basic code which represents information.

For the purposes of computing machines, information is an arrangement or positioning of equipment, and the social meaning of the arrangement makes no difference, except at the input and the output.

Handling Information

How does a machine take in, record, and remember information?

In every case the machine contains equipment which can receive and record information. The ways in which the information may be taken in and recorded vary widely.

One way, for example, is by punching holes in paper tape or in a card, and then passing this tape or card into the machine; and the presence or the absence of the holes is detected by the machine by means of metal fingers or by closed or opened electrical circuits, and this causes the machine to store the pattern of the information in some part of its equipment. This is the digital form of information, a series of separate and distinct symbols, digits, letters, characters, yeses and noes; and the kind of computer which takes in and manipulates information in this form is called digital.

In general, in a digital machine, in the course of a problem, each separate piece of information has to be remembered for a long or short time. It is stored in unchanging form in some of the equipment of the machine, called a register or a location. This might be for example a set of counter wheels, as in a desk adding machine, or a set of relays, as in a telephone system. Many automatic digital computers have 1000 registers for storing internally 1000 pieces of information at any one time. Any piece of information when called for is accessible to the calculating section of the machine with a very small waiting time.

A second way of putting information into a machine is for example by turning a dial or a wheel a certain amount, and causing some of the equipment in the machine to record how much turning has taken place. This is the method used in the automobile speedometer and the steering mechanism of a ship. This is the analog form of information, a magnitude of something or other, more exactly, a magnitude of a physical variable such as position, rotation, or voltage. The kind of machine which takes in and manipulates information in this form is called analog.

In general, in an analog machine, in the course of a problem, each different quantity occurring (either input or output or intermediate) is remembered for the whole time in a separate mechanism. This might be a rotating shaft, as in a fire control computer, or some electrical component, as in an electronic analog computer. This mechanism by its position or voltage or motion, etc., represents — in fact, measures — the quantity in the problem. Some automatic analog computers of very high capacity may have 100 mechanisms for storing internally 100 quantities throughout the problem. Each mechanism is interconnected physically in a way that mirrors the mathematical relationship so that as time goes by the simultaneous change of all the mechanisms solves the problem.

It should be possible for one and the same machine to take in digital information in some ways and analog information in other ways, and this kind of machine may in the future combine the best features of both types of machines.

A simple everyday example of a small machine that can receive and record information in a digital way is the ordinary date stamp, that can stamp JUN 30 1954 for instance. The

date stamp is made up of a frame, four rollers, and four little rubber belts; one of the belts contains in raised, reversed letters the month symbols JAN, FEB, MAR and so on down to DEC; two more little belts contain each the digits 0, 1, 2 up to 9; and the fourth belt contains say the years 1952, 1953, 1954, 1955, 1956, 1957. The date stamp at the beginning of a day is set by hand so that it records and thereby stores the date which that day is. Then the user of the date stamp, without himself remembering the date, can impress it on any sheet of paper and the machine will immediately state the date. When the day changes to the next one, the date shown by the stamp can be changed of course by turning small burred wheels next to each roller, thus changing the position of one or more rubber belts. In fact, if we should so desire, we could connect the date stamp to an electric alarm clock set to go off each midnight, thereby providing an impulse which (with a sufficiently Rube Goldberg apparatus) could cause the date stamp to be changed automatically from one date to the next date. We would then have a rudimentary automatic computer, able not only to take in and record information but also to manipulate it logically.

A simple everyday example of a small machine that can receive and record information in an analog way is a thermometer. This machine takes in and records the temperature of its surroundings. The length of its column of bright red liquid, when appropriately scaled, matches up with the temperature of the surrounding air. Yet it does not report immediately because it takes about three minutes, when moved into a new environment, for the thermometer to reach the temperature of its environment. One might argue that the graduations on the scale of the thermometer convert it into a digital machine; but this digital reporting (found in all analog computers to make it easy to copy down the answer) is extraneous to the analog character of the machine.

But there is no very easy way to hitch mechanically the temperature-responding length of one column of red liquid and the length of another column of such liquid; and so analog computers use other means than these for nearly all purposes of computation.

Actual Processing of Information

How does a machine manipulate information? How does it actually compute?

To explain the different ways in which a computer actually computes, suppose we take a sample operation with information and show how it is handled by a human being engaged in computing and by a computing machine.

Let us take for the sample operation, the operation of finding twice a number, the operation expressed by the formula "p equals 2 times n", where p and n are numbers.

A human being will find twice a number in the following way. First, you have to tell him the number. Suppose that it is 76, -- that is, in this case n is to be 76. Then he will refer to the "two times" multiplication table which he has learned by heart, and will go through a procedure which he also learned by heart while in grade school. On paper he will write:

$$\begin{array}{r} 76 \\ \underline{\times\ 2} \\ 152 \end{array}$$

but under his breath, as he writes this, he will say the procedure that he learnt:

> "2 times 6 is 12; put down the 2 and carry the 1; 2 times 7 is 14, and 1 to carry is 15, put down the 5 and carry the 1; there is nothing in the third column; 2 times zero is zero, and the 1 to be carried makes 1; put down the 1; the answer is 152."

An automatic analog computing machine will find twice a number in the following way. Suppose that the machine represents and stores each number by the amount of turning of a shaft or rod or axle. Imagine two shafts parallel to each other. We slide on to one of the shafts, the one which represents n, a gear with say 36 teeth. We slide on the other shaft, the one which represents p, a gear with 18 teeth -- half as many teeth. We mesh the gears with each other and tighten them on their shafts so that they will not slip. We put a crank on shaft n so that we can turn it and thereby drive shaft p. Now we can see that no matter how much or how little we turn shaft n, shaft p will have to turn twice as much; and if shaft n has had 76 turns, then shaft p without any doubt at all must have had 152 turns. We notice that in this case the machine is set to compute twice a number without our having to tell the machine specifically some particular number to begin with.

An automatic digital computing machine will find twice a number in the following way. In the first place such a computer is organized like a railroad system. This railroad system has four stations: Input; Output; Storage, which may contain 1000 sidings or registers; and Calculator, a kind of factory which may have registers A and B for receiving two numbers being operated on, a register Op for receiving the operation, and a final register R for sending out the result of the operation. It also has a signal tower, Control. The units of information are like freight cars, which are

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Glossary of Terms in the Field of Computers and Automation

(Glossary, Third Edition, December 10, 1955)

The following is a glossary of terms and expressions used in the field of computers and automation. The purpose of this glossary is to report or indicate the meanings of terms as used. This glossary draws from previously published glossaries, and from discussions of glossaries and the making of them.

This glossary consists of two sections, of which by far the longer is the second section. This is substantially a reprint of the "Glossary of Terms and Expressions in the Field of Computers and Automation" published in "Computers and Automation", December 1954, vol. 3, no. 10. Changes have been made in the definitions of the following terms: access time, bus (not "buss"), capacity, card, cathode ray tube, character, dump, electronic, extract, flip-flop, jump, machine word, marginal checking, read-around-ratio, rerun point (not "return point"), significant digits, skip, static storage, transfer instruction, two-address, word.

The first section contains some definitions of terms not appearing in the preceding glossary, and also some new or additional definitions of terms that did appear there.

As always, additions, comments, corrections, and criticisms are invited.

One remark: since almost all of the glossary of a year ago was unchanged, it seemed that the most practical way to prepare this edition was to present undisturbed as much as possible of the prior edition, in Section 2 here, and present the main changes and additions separately, in Section 1 here.

SECTION 1

acoustic memory -- Computers. Computer memory which uses a sonic delay line, one which employs a train of pulses in the molecules of a medium such as mercury or quartz.

*1 cathode ray tube -- Digital Computers. 2. A similar tube with a screen for visual display of output in graphic form.

clock frequency -- Digital Computers. The master frequency of periodic pulses which schedules the operation of the computer.

data -- Computers. Any facts or information, particularly as taken in, operated on, or put out by a computer or other machine for handling information.

data processor -- A machine for handling information in a sequence of reasonable operations.

decision element -- Circuits. A circuit which performs a logical operation, such as AND, OR, NOT, or EXCEPT, on one, two, or several binary digits representing "yes" or "no".

*2 dump -- 2. Digital Computer Programming. To transfer all or part of the contents of one section of computer memory into another section.

dump check -- A check which usually consists of adding all the digits during dumping, and verifying the sum when retransferring.

*3 electronic -- (add:) Exceptions: The term "electronic" also includes flows of electrons in semiconducting devices such as transistors and diodes, and also some cases of large flows in vacuums.

feedback -- The returning of a fraction of the output of a machine, system, or process to the input, to which the fraction is added or subtracted. If increase of input is associated with increase of output, subtracting the returned fraction (negative feedback) results in self-correction or control of the process, while adding it (positive feedback) results in a runaway or out of control process.

*4 flip-flop -- 2. An electronic circuit having two stable states, one input line, and one output line, such that as each successive pulse is received, the voltage on the output line changes, if it is low, to high, and if it is high, to low.

*5 machine word -- See also "information word".

*6 marginal checking -- Computer Circuits. A system of designing electronic circuits in a computer so that certain parameters of the circuits may be varied, and the circuits tested to determine if they continue to operate satisfactorily. For example, the voltage of the heaters of the tubes ordinarily established at 6.3 volts, may be lowered to 5 or 4.7 volts; or the operating frequency of computer cycles may be increased; or the screen voltage of the cathode ray tubes may be lowered; etc.

preventive maintenance ---Maintenance of any system which aims to prevent failures ahead of time rather than eliminate failures which have occurred.

selectron -- Digital Computers. A type of electronic tube for computer memory which stores 256 binary digits for very rapid selection and access.

servomechanism -- A power-driven apparatus that exerts a strong force and supplements a primary control operated by a comparatively feeble force.

*7 significant digits -- Computation. Digits appearing in the coefficient of a number when the number is written as a coefficient between 1.000.....and 9.999.....times a power of ten (called scientific normal form); and similarly for any base of notation other than 10.

Examples: 000376, which is equal to 3.76 times 10^{-4}, has three significant digits; 12 million, equal to 1.2 times 10^7 has two significant digits; 300600, equal to 3.006 times 10^5, has four significant digits; in "J. B. Smith's book had exactly 1000 pages", the 1000 has four significant digits, although ordinarily 1000 would have only one significant digit.

*8 word -- (add:) Also called "machine word" or information word", which may however be different since the machine word may include spaces between words while the information word may not.

SECTION II

A: absolute address -- Digital Computer Programming. The label assigned by the machine designer to a specific register or location in the storage.

absolute coding -- Coding that uses absolute addresses.

-ac -- An ending that means "automatic computer", as in Eniac, Seac, etc.

access time -- Digital Computers. 1. The time interval between the instant at which the arithmetic unit calls for information from the memory unit and the instant at which the information is delivered from storage to the arithmetic unit. 2. The time interval between the instant at which the arithmetic unit starts to send information to the memory unit and the instant at which the storage of the information in the memory unit is completed. -- In analog computers, the value at time t of each dependent variable represented in the problem is usually immediately accessible when the value of the independent variable is at time t, and otherwise not accessible.

accumulator -- Digital Computers. (1) A unit in a digital computer where numbers are totaled, that is, accumulated. (2) A register in the arithmetic unit of a digital computer where the result of arithmetical or logical operations is first produced. -- Often the accumulator stores one quantity and upon receipt of any second quantity, it forms the sum of the first and the second quantities and stores that instead. Sometimes the accumulator is able to perform other operations upon a stored quantity in its register such as sensing, shifting, complementing, etc.

accuracy -- Correctness, or freedom from error. Accuracy contrasts with precision; for example, a four-place table, correctly computed, is accurate; while a six-place table containing an error is more precise but not accurate.

adder -- Computers. A device that can form the sum of two quantities delivered to it. Examples are: an accumulator; a differential gear assembly; etc.

address -- Digital Computers. A label, name, or number identifying a register, a location, or a device where information is stored. See also: absolute address, floating address, relative address, symbolic address.

addressed memory -- Digital Computers. The sections of the memory where each individual register bears an address. -- In storage on magnetic tape, usually only blocks of a number of items of information have addresses, and an individual item does not have an individual address associated with it.

alphabetic coding -- A system of abbreviation used in preparing information for input into a machine, such that information may be reported not only in numbers but also in letters and words. For example, Boston, New York, Philadelphia, Washington, may in alphabetic coding be reported as BS, NY, PH, WA. Some computers will not accept alphabetic coding but require all abbreviations to be numerical, in which case these places might be coded as 0, 1, 2, 3.

analog -- Using physical variables, such as distance or rotation or voltage, or measurements of similar physical quantities, to represent and correspond with numerical variables that occur in a computation; contrasted with "digital".

analog computer -- A computer which calculates by using physical analogs of the variables. Usually a one-to-one correspondence exists between each numerical variable occurring in the problem and a varying physical measurement in the analog computer.

and -- Logic. A logical operator which has the property that if P and Q are two statements, then the statement "P AND Q" is true or false precisely according to the following table of possible combinations:

P	Q	P AND Q
false	false	false
false	true	false
true	false	false
true	true	true

The AND operator is often represented by a centered dot (·), or by no sign, as in P·Q, PQ.

'and' circuit -- Circuits. A pulse circuit with two input wires and one output wire, which has the property that the output wire gives a pulse if and only if both of the two input wires receive pulses. Also called a "gate" circuit.

arithmetic check -- A check of a computation, making use of arithmetical properties of the computation; for example, checking the multiplication A x B by comparing it with B x A.

arithmetic operation -- An operation in which numerical quantities form the elements of the calculation. Such operations include the "fundamental operations of arithmetic", which are addition, subtraction, multiplication and division.

arithmetic shift -- The multiplication or division of a quantity by a power of the base of notation. For example, since 1011 represents eleven in binary notation, the result of two arithmetic shifts to the left is 101100, which represents forty-four.

arithmetic unit -- Digital Computers. The section of the hardware of a computer where arithmetical and logical operations are performed on information.

asynchronous computer -- Digital Computers. An automatic computer where the performance of any operation starts as a result of a signal that the previous operation has been completed; contrasted with "synchronous computer", which see.

automatic carriage -- Punch Card Machines. A typewriting carriage which is automatically controlled by information and program so as to feed forms or continuous paper, space, skip, eject, tabulate, etc. It may produce any desired style of presentation of information on separate forms or on continuous paper.

automatic checking -- Computers. Provision, constructed in hardware, for automatically verifying the information, transmitted, manipulated or stored by any device or unit of the computer. Automatic checking is "complete" when every process in the machine is automatically checked; otherwise it is partial. The term "extent of automatic checking" means either (1) the relative proportion of machine processes which are checked, or (2) the relative proportion of machine hardware devoted to checking.

automatic computer -- A computer which automatically handles long sequences of reasonable operations with information.

automatic controller -- A device which controls a process by (1) automatically receiving measurements of one or more physical variables of the process, (2) automatically performing a calculation, and (3) automatically issuing suitably varied actions, such as the relative movement of a valve, so that the process is controlled as desired; for example, a flyball governor on a steam engine; an automatic pilot.

automatic programming -- Digital Computer Programming. Any technique whereby the computer itself is used to transform programming from a form that is easy for a human being to produce into a form that is efficient for the computer to carry out. Examples of automatic programming are compiling routines, interpretive routines, etc.

automation -- 1. Process or result of rendering machinesself-acting or self-moving; rendering automatic. 2. Theory or art or technique of making a device or a machine or an industrial process more fully automatic. 3. Making automatic the process of moving pieces of work from one machine tool to the next.

available machine time -- Time that a computer has the power turned on, is not under maintenance, and is known or believed to be operating correctly.

average calculating operation -- A common or typical calculating operation longer than an addition and shorter than a multiplication; often taken as the mean of nine additions and one multiplication.

B: base -- Numbers. Ten in the decimal notation of numbers, two in the binary notation of numbers, eight in octal notation, and in general the radix in any scale of notation for numbers.

binary -- Involving the integer two. For example, the binary number system uses two as its base of notation. A binary choice is a choice between two alternatives; a binary operation is one that combines 2 quantities.

binary cell -- An element that can have one or the other of two stable states or positions and so can store a unit of information.

binary-coded decimal notation -- One of many systems of writing numbers in which each decimal digit of the number is expressed by a different code written in binary digits. For example, the decimal digit zero may be represented by the code 0011, the decimal digit one may be represented by the code 0100, etc.

binary digit -- A digit in the binary scale of notation. This digit may be only 0 (zero) or 1 (one). It is equivalent to an "on" condition or an "off" condition, a "yes" or a "no", etc.

binary notation -- The writing of numbers in the scale of two. The first dozen numbers zero to eleven are written 0, 1, 10, 11, 100, 101, 110, 111, 1000, 1001, 1010, 1011. The positions of the digits designate powers of two; thus 1010 means 1 times two cubed or eight, 0 times two squared or four, 1 times two to the first power or two, and 0 times two to the zero power or one; this is equal to one eight plus no four's plus one two plus no ones, which is ten.

binary number -- A number written in binary notation.

binary point -- In a binary number, the point which marks the place between integral powers of two and fractional powers of two, analogous to the decimal point in a decimal number. Thus, 10.101 means four, one half, and one eighth.

binary to decimal conversion -- The mathematical process of converting a number written in binary notation to the equivalent number written in the ordinary decimal notation.

biquinary notation -- Numbers. A scale of notation in which the base is alternately 2 and 5. For example, the number 3671 in decimal notation is 03 11 12 01 in biquinary notation; the first of each pair of digits counts 0 or 1 units of five, and the second counts 0, 1, 2, 3, or 4 units. For comparison, the same number in Roman numerals is MMMDCLXXI. Biquinary notation expresses the representation of numbers by the abacus, and by the two hands and five fingers of man; and has been used in some automatic computers.

bit -- A binary digit; a smallest unit of information; a "yes" or a "no"; a single pulse in a group of pulses.

block -- Digital Computers. A group of consecutive machine words considered or transferred as a unit, particularly with reference to input and output.

bootstrap -- Digital Computer Programming. The coded instructions at the beginning of an input tape, together with one or two instructions inserted by switches or buttons into the computer, used to put a routine into the computer.

break-point -- Digital Computer Programming. A point in a routine at which the computer may, under the control of a manually set switch, be stopped for an operator's check of the progress of the routine.

buffer -- Circuits. 1. An isolating circuit used to avoid any reaction of a driven circuit upon the corresponding driving circuit. 2. A cir-

cuit having an output and a multiplicity of inputs so designed that the output is energized whenever one or more inputs are energized. Thus, a buffer performs the circuit function which is equivalent to the logical "or", which see.

buffer storage -- Digital Computers. 1. Equipment linked to an input device, in which information is assembled from external storage and stored ready for transfer to internal storage. 2. Equipment linked to an output device into which information is transmitted from internal storage and held for transfer to external storage. Computation continues while transfers between buffer storage and external storage take place.

bus -- Digital Computers. A path over which information is transferred, from any of several sources to any of several destinations; a channel, line, or trunk.

C: call-number -- Digital Computer Programming. A set of characters identifying a subroutine, and containing information concerning parameters to be inserted in the subroutine, or information to be used in generating the subroutine, or information related to the operands.

call-word -- Digital Computer Programming. A call-number which fills exactly one machine word.

capacity -- Digital Computer Arithmetic. 1. The number of digits or characters which may regularly be processed in a computer, as in "the capacity is ten decimal digit numbers". 2. The upper and lower limits of the numbers which may regularly be handled in a computer, as "the capacity of the computer is + .00000 00001 to .99999 99999". Quantities which are beyond the capacity of the computer usually interrupt its operation in some way.

card -- Computers. A card of constant size and shape, adapted for being punched in a pattern which has meaning. The punched holes are sensed electrically by wire brushes, mechanically by metal fingers, or photo-electrically. Also called "punch card." One of the standard punch cards (made by International Business Machines Corporation) is 7 and 3/8 inches long by 3 and 1/4 inches wide, and contains 80 columns in each of which any one of 12 positions may be punched.

card column -- Punch Card Machines. One of a number of columns (45, 80, or 90) in a punch card into which information is entered by punches.

card feed -- Punch Card Machines. A mechanism which moves cards one by one into a machine.

card field -- Punch Card Machines. A set of card columns fixed as to number and position, into which the same item of information is regularly entered; for example, purchase order numbers of five decimal digits might be punched regularly into the card field consisting of card columns 11 to 15.

card stacker -- Punch Card Machines. A mechanism that stacks cards in a pocket or bin after they have passed through a machine. Sometimes called "card hopper".

card reader -- Punch Card Machines. A mechanism that causes the information in cards to be read, usually by passing them under copper wire brushes or across metal fingers.

card punch -- Punch Card Machines. A mechanism which punches cards, or a machine which punches cards according to a program.

carry -- Arithmetic. 1. The digit to be taken to the next higher column (and there added) when the sum of the digits in one column equals or exceeds the number base. 2. The process of transferring the carry digit to the next higher column.

cathode ray tube -- Digital Computers. 1. A large electronic vacuum tube containing a screen on which information, expressed in pulses in a beam or ray of electrons from the cathode, is stored by means of the presence or absence of spots bearing electrostatic charges. The capacity usually is from 256 to 1024 spots. *1

cell -- Digital Computers. Storage for one unit of information, usually one character or one machine word. More specific terms ("column, location, block") are preferable since there is little uniformity in the use of the term "cell".

channel -- Digital Computers. 1. A path along which information, particularly a series of digits or characters or units of information, may flow or be stored. For example, in the machine known as a punch card reproducer, information (in the form of punch cards) may flow in either one of two card channels which do not physically connect. 2. Magnetic Tape or Magnetic Drums. A path parallel to the edge of the tape or drum along which information may be stored by means of the presence or absence of polarized spots, singly or in sets. 3. Delay Line Memory such as a Mercury Tank. A circular path forward through the delay line memory and back through electrical circuits along which a pattern of pulses representing information may be stored.

character -- Digital Computers. 1. A decimal digit 0 to 9, or a letter A to Z, either capital or lower case, or a punctuation symbol, or any other single symbol (such as appear on the keys of a typewriter) which a machine may take in, store, or put out. 2. A representation of such a symbol in a pattern of ones and zeros representing a pattern of positive and negative pulses or states.

check digit -- One or more digits carried along with a machine word (i.e., a unit item of information handled by the machine), which report information about the other digits in the word in such fashion that if a single error occurs (excluding two compensating errors), the check will fail and give rise to an error alarm signal. For example, the check digit may be 0 if the sum of other digits in the word is odd, and the check digit may be 1 if the sum of other digits in the word is even.

circulating memory -- Digital Computers. A device using a "delay line" which stores information in a train of pulses or waves, as a pattern of the presence or absence of such pulses, where the pattern of pulses issuing at the final end of the delay line is detected electrically, amplified, reshaped, and reinserted in the delay line at the beginning end.

closed subroutine -- Digital Computer Programming. A subroutine with the following properties: (1) it is stored separately from the main routine; (2) at the proper point in the main routine, a jump instruction transfers control to the beginning of the subroutine; (3) at the end of the subroutine, another jump instruction transfers control back to the proper point in the main routine.

clear (verb) -- Digital Computers. To replace information in a register by zero as expressed in the number system employed.

code (noun) -- Computers. A system of symbols for representing information in a computer and the rules for associating them.

code (verb) -- Computers. To express information, particularly problems, in language acceptable to a specific computer.

coded decimal (adjective) -- Computers. A form of notation by which each decimal digit separately is converted into a pattern of binary ones and zeros. For example, in the "8-4-2-1" coded decimal notation, the number twelve is represented as 0001 0010 (for 1, 2) whereas in pure binary notation it is represented as 1100. Other coded decimal notations are known as: "5-4-2-1", "excess three", "2-4-2-1", etc.

coded decimal digit -- A decimal digit which is expressed by a pattern of four or more ones and zeros.

coded program -- A program which has been expressed in the code for a computer.

coder -- A person who translates a sequence of instructions for an automatic computer to solve a problem into the precise codes acceptable to the machine.

coding -- The list in computer code of the successive computer operations required to carry out a given routine or subroutine or solve a given problem.

coding line -- A single command or instruction written usually on one line, in a code for a computer to solve a problem.

collate -- To combine two sequences of items of information in any way such that the same sequence is observed in the combined sequence. For example, sequence 12, 29, 42 and sequence 23, 24, 48 may be collated into 12, 23, 24, 29, 42, 48. More generally, to combine two or more similarly ordered sets of items to produce another ordered set composed of information from the original sets. Both the number of items and the size of the individual items in the resulting set may differ from those of either of the original sets and of their sum .

collator -- Punch Card Machines. A machine which has two card feeds, four card pockets, and three stations at which a card may be compared or sequenced with regard to other cards, so as to determine the pocket into which it is to be placed. The machine is particularly useful for matching detail cards with master cards, for merging cards in proper sequence into a file of cards, etc.

column -- 1. Writing. The place or position of a character or a digit in a word, or other unit of information. 2. Computers. One of the characters or digit positions in a positional notation representation of a unit of information. Columns are usually numbered from right to left, zero being the rightmost column if there is no decimal (or binary, or other) point, or the column immediately to the left of the point if there is one. 3. Arithmetic. A position or place in a number, such as 3876, written in a scale of notation, corresponding to a given power of the radix. The digit located in any particular column is the coefficient of the corresponding power of the radix; thus, 8 in the foregoing example is the coefficient of 10^2.

command -- A pulse, signal, or set of signals initiating one step in the performance of a computer operation.

comparator -- 1. Circuits. A circuit which compares two signals and supplies an indication of agreement or disagreement; or a mechanism by means of which two items of information may be compared in certain respects, and a signal given depending on whether they are equal or unequal. 2. Computers. A device for comparing two different transcriptions of the same information to verify agreement or determine disagreement.

comparison -- Computers. The act of comparing and, usually, acting on the result of the comparison. The common forms are comparison of two numbers for identity, comparison of two numbers for relative magnitude, and comparison of two signs plus or minus.

compiler -- Digital Computer Programming. A program-making routine, which produces a specific program for a particular problem by the following process: (1) determining the intended meaning of an element of information expressed in pseudo-code; (2) selecting or generating (i.e., calculating from parameters and skeleton instructions) the required subroutine; (3) transforming the subroutine into specific coding for the specific problem, assigning specific memory registers, etc., and entering it as an element of the problem program; (4) maintaining a record of the subroutines used and their position in the problem program; and (5) continuing to the next element of information in pseudocode.

compiling routine -- Computers. A routine by means of which a computer can itself construct the program to solve a problem by assembling, fitting together, and copying other programs stored in its library of routines. Same as "compiler", which see.

complement -- Arithmetic. A quantity which is derived from a given quantity, expressed in notation to the base n, by one of the following rules. (a) Complement on n: subtract each digit of the given quantity from n-1, add unity to the rightmost digit, not zero and perform all resultant carries. For example, the twos complement of binary 11010 is 00110; the tens complement of decimal 679 is 321. (b) Complement on n-1: subtract each digit of the given quantity from n-1. For example, the ones complement of binary 11010 is 00101; the nines complement of decimal 679 is 320. The complement is frequently employed in computers to represent the negative of the given quantity.

complete operation -- Computers. A calculating operation which includes (1) obtaining all the numbers entering into the operation out of the memory, (2) making the calculation, (3) putting the results back into the memory, and (4) obtaining the next instruction.

computer -- 1. A machine which is able to calculate or compute, that is, which will perform sequences of reasonable operations with information, mainly arithmetical and logical operations. 2. More generally, any device which is capable of accepting information, applying definite reasonable processes to the information, and supplying the results of these processes.

computing machinery -- Machinery which is able to

take in and give out information, perform reasonable operations with the information, and store information.

computer code — Computers. The code expressing the operations built into the hardware of the computer.

computer operation — Computers. The electronic, mechanical, or other physical operation of hardware in a computer resulting from an instruction to the computer.

conditional — Computers. Subject to the result of a comparison made during computation; subject to human intervention.

conditional breakpoint instruction — Digital computer Programming. A conditional jump instruction which, if some specified switch is set, will cause the computer to stop, after which either the routine may be continued as coded or a jump to another routine may be directed.

conditional transfer of control — Digital Computers. A computer instruction which when reached in the course of a program will cause the computer either to continue with the next instruction in the original sequence or to transfer control to another stated instruction, depending on a condition regarding some property of a number or numbers which has then been determined.

contents — Digital Computers. The information stored in any part of the computer memory. The symbol "(...)" is often used to indicate "the contents of..."; for example, (m) indicates the contents of the storage location whose address is m.

control (verb) — Digital Computers. To direct the sequence of execution of the instructions to a computer.

control circuits — Digital Computers. The circuits which effect the carrying out of instructions in proper sequence.

control register — Digital Computers. The register which stores the current instruction governing the operation of the computer for a cycle.

control sequence — Digital Computers. The normal sequence of selection of computer instructions for execution. In some computers, one of the addresses in each instruction specifies the control sequence. In most other computers the sequence is consecutive except where a jump occurs.

control unit — Digital Computers. That portion of the hardware of an automatic digital computer which directs the sequence of operations, interprets the coded instructions, and initiates the proper signals to the computer circuits to execute the instructions.

converter — A machine which changes information in one kind of language acceptable to a machine into corresponding information in another kind of language acceptable to a machine. For example, a machine which takes in information expressed in punch cards and produces the same information expressed in magnetic tape, is a "converter". Often the machine possesses limited computing facilities, spoken of as "editing facilities".

copy — Digital Computers. To transfer information stored in one memory register into another memory register, leaving unchanged the information in the first register, and replacing whatever was previously stored in the second register.

counter — A mechanism which either totals digital numbers, or allows digital numbers to be increased by additions of one in any column of the number. It is also able to be reset to zero.

crippled leap-frog test — Digital Computer Programming. A variation of the leap-frog test described below, modified so that it repeats its tests from a single set of storage locations and does not "leap".

cybernetics — 1. The study of control and communication in the animal and the machine. 2. The art of the pilot or steersman. 3. The comparative study of complex information-handling machinery and the nervous systems of the higher animals including man in order to understand better the functioning of brains.

cycle (verb) — Computers. To repeat a set of operations a specified number of times including, when required, supplying necessary memory location address changes by arithmetic processes or by means of a hardware device such as a cycle-counter.

cycle (noun) — 1. A set of operations repeated as a unit. 2. Computers. The smallest period of time or complete process of action that is repeated in order. In some computers, "minor cycles" and "major cycles" are distinguished. 3. Computer Arithmetic. A shift of the digits of a number such that digits removed from one end of the word are inserted in sequence at the other end of the word, in circular fashion.

cycle criterion — Digital Computer Programming. The total number of times that a cycle is to be repeated, or the register which stores that number.

cycle index — Digital Computer Programming. The number of times a cycle has been executed; or the difference (or the negative of the difference) between that number and the number of repetitions desired.

cycle reset — Digital Computer Programming. The returning of a cycle index to its initial value.

cyclic shift — Computer Arithmetic. A shift of the digits of a number (or the characters of a word) in which digits removed from one end of the word are inserted in the same sequence at the other end of the word, in circular fashion.

D: DC dump — Digital Computers. The condition resulting when direct current power is withdrawn from a computer which uses volatile storage, i.e., loss of information stored in such storage.

debug — Computers. To isolate and remove malfunctions from a computer or mistakes from a program.

decade — A group of ten; for example, a "decade counter" will count to ten in one column or place of a decimal number.

decimal digit — One of the symbols 0, 1, 2, 3, 4, 5, 6, 7, 8, 9 when used in numbering in the scale of ten. Two of these digits, 0 and 1, are of course also binary digits when used in numeration in the scale of two.

decimal notation — The writing of quantities in the scale of ten.

decimal point — In a decimal number, the point

that marks the place between integral and fractional powers of ten.

decimal-to-binary conversion -- Mathematical process of converting a number written in the scale of ten into the same number written in the scale of two.

delay line -- Computers. A device which stores information in a train of pulses or waves, and as a pattern of the presence or absence of such waves. An example of a delay line in everyday life is an echo; the air and a reflecting wall momentarily store a train of sound waves. In a computer delay line, the medium may be mercury, the container a pipe, and the pulses issuing at the final end may be detected electrically, amplified, reshaped, and reinserted at the beginning end.

diagnostic routine -- Digital Computer Programming. A specific routine designed to locate either a malfunction in the computer or a mistake in coding.

diagram — Digital Computer Programming. A schematic representation of a sequence of subroutines designed to solve a problem. It is a less detailed and less symbolic representation than a flow chart, and frequently includes descriptions in English words.

differential analyzer -- An analog computer designed particularly for solving or "analyzing" many types of differential equations.

differentiator -- Analog Computers. A device whose output signal is proportional to the derivative of an input signal.

digit -- 1. One of the symbols 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, used in numbering in the scale of ten. 2. One of these symbols and sometimes also letters expressing integral values ranging from 0 to n-1 inclusive, used in a scale of numbering to the base n.

digital -- Using numbers expressed in digits and in a scale of notation, in order to represent all the variables that occur in a problem.

digital computer -- A computer which calculates using numbers expressed in digits and yeses and noes expressed usually in 1's and 0's, to represent all the variables that occur in a problem.

digitize — To change an analog measurement of a physical variable into a number expressed in digits in a scale of notation.

double precision -- Digital Computers. Having twice as many digits as the quantities normally handled in the computer. For example, in the case of a desk calculator regularly handling ten place decimal numbers, computation with 20 place numbers by keeping track of the 10 place fragments, is "double precision" computation.

down-time -- Computer Operation. Time when a computer is malfunctioning, or not operating correctly, due to machine failure.

dummy — Digital Computer Programming. An artificial address, instruction, or other unit of information inserted solely to fulfill prescribed conditions (such as word-length or block-length) without affecting operations.

dump -- 1. Computer Operation. To withdraw all power accidentally or intentionally. *2

duplication check — A check which requires that the results of two independent performances (either concurrently on duplicate equipment or at a later time on the same equipment) of the same operation be identical.

dynamic storage -- Storage such that information at a certain position is changing over time and so is not always available instantly; for example, acoustic delay line storage or magnetic drum storage.

dynamic subroutine -- Digital Computer Programming. A subroutine which involves parameters, such as decimal point position or item size, from which a relatively coded subroutine is derived. The computer itself is expected to adjust or generate the subroutine according to the parametric values chosen.

E: edit — Digital Computer Programming. To arrange or rearrange information for the output unit to print. Editing may involve the deletion of unwanted data, the selection of pertinent data, the insertion of invariant symbols such as page numbers and typewriter characters, and the application of standard processes such as zero-suppression.

education of a computer -- Computers. Preparing and assembling programs for a computer so that the computer can itself put together many programs for many purposes. This greatly reduces the time required from human programmers to program the computer.

electric typewriter -- A typewriter having an electric motor and the property that almost all the operations of the machine after the keys are touched by human fingers are performed by electric power instead of the power of human fingers and hands.

electronic (as contrasted with "electric") -- In general, dealing with flows of small numbers of electrons in a vacuum, as contrasted with flows of large numbers of electrons along wire conductors. *3

electronic calculating punch — Punch Card Machines. A punch card machine which, in each fraction of a second reads a punch card passing through the machine, performs a number of sequential operations, and punches a result on the punch card.

electrostatic storage -- Storage of information in the form of the presence or absence of spots bearing electrostatic charges. See "cathode ray tube".

equation solver -- A computing device, often analog, which is designed to solve systems of linear simultaneous (nondifferential) equations or find the roots of polynomials, or both.

equivalent binary digits -- Number of binary digits equivalent to a given number of decimal digits or other characters. When a decimal number is converted into a binary number, the number of binary digits necessary is in general equal to about 3 1/3 times the number of decimal digits. In coded decimal notation, the number of binary digits necessary is ordinarily 4 times the number of decimal digits.

erasable storage -- Storage media which can be erased and reused; for example, magnetic tapes.

erase -- Digital Computers. 1. To remove information from storage and leave the space available for recording new information. 2. To replace all the binary digits in a storage device by binary zeros. In a binary computer, erasing is equivalent to clearing, while in a coded decimal computer where the pulse code for decimal zero may contain binary ones, clear-

ing leaves decimal zero while erasing leaves all-zero pulse codes.

error -- The amount of loss of precision in a quantity; the difference between an accurate quantity and its calculated approximation. Errors occur in numerical methods; mistakes occur in programs, coding, data transcription, and operating; malfunctions occur in computers.

excess-three code -- A coded decimal notation for decimal digits which represents each decimal digit as the corresponding binary number plus three. For example, the decimal digits 0, 1, 8, 9, are represented as 0011, 0100, 1011, 1100, respectively. As may be seen, in this notation, the nines complement of the decimal digit is equal to the ones complement of the corresponding four binary digits.

exchange -- Digital Computer Programming. To interchange the contents of two storage devices or locations.

executive routine -- Digital Computer Programming. A routine designed to process and control other routines.

external memory -- Digital Computers. Materials separate from the computer itself but holding information stored in language acceptable to the machine, as for example, recorded magnetic tape in a closet, or punch cards in filing cabinets.

extract -- Computers. 1. To obtain certain digits from a machine word as may be specified. For example, if the ten digit number 0000011100 is stored in a machine register, the computer can be instructed to "extract" the eight digit from the left (in this case a one) and correspondingly perform a certain action. 2. Computers. To replace the contents of specific columns of one machine word by the contents of the corresponding columns of another machine word, depending on the instruction. 3. To remove from a set of items of information all those items that meet some arbitrary condition.

F: field -- 1. Punch Card Machines. A set of one or more columns in each of a number of punch cards which is regularly used to report a standard item of information. For example, if columns 16 to 19 are regularly used to report weekly rate of pay, then these columns would constitute a field. 2. Computers. A set of one or more characters (not necessarily all lying in the same word) which is treated as a whole; a unit of information.

fixed-cycle operation -- Computers. Organization of a computer whereby a fixed time is allocated to operations, although they may actually take less time than is allocated. This is the type of operation of a "synchronous" computer.

fixed-point calculation -- Computers. Calculation using or assuming a fixed or constant location of the decimal point or the binary point in each number.

fixed-point representation -- Arithmetic. An arithmetical notation in which all numerical quantities are expressed by the same specified number of digits, with the point implicitly located at the same specified position.

flip-flop -- Circuits. 1. An electronic circuit having two stable states, two input lines, and two corresponding output lines such that a signal exists on either one of the output lines if and only if the last pulse received by the flip-flop is on the corresponding input line. *4

floating-point calculation -- Computers. Calculation taking into account varying location of the decimal point (if base 10) or binary point (if base 2), and consisting of writing each number by specifying separately its sign, its coefficient, and its exponent affecting the base. For example, in floating-point calculation, the decimal number -638, 020, 000 might be reported as -,6.3802,8, since it is equal to -6.3802×10^8.

flow chart -- Digital Computer Programming. A graphical representation of a sequence of programming operations, using symbols to represent operations such as compute, substitute, compare, jump, copy, read, write, etc. A flow chart is a more detailed representation than a diagram, which see.

force (verb) -- Digital Computer Programming. To intervene.

four-address (adjective) -- Digital Computer Programming. Having the property that each complete instruction specifies the operation and the addresses of four registers. Usually each instruction contains the addresses of three operands (i.e., the numbers being operated with), the operation, and the address of the next order.

function switch -- Circuits. A network or circuit having a number of inputs and outputs and so connected that signals representing information expressed in a certain code, when applied to the inputs, cause output signals to appear which are a function of the input information.

function table -- 1. Mathematics. A table of the values for a mathematical function. 2. Computers. A hardware device or a program which translates from one representation of information to another representation.

G: gate -- Circuits. An electronic circuit with two inputs and one output, which has the property that a pulse goes out on the output line if and only if some specified combination of pulses occurs on the two input lines. The combination may be the presence of pulses on both input lines, which is called an "and" gate, or the presence of a pulse on one line and the absence of a pulse on the other line, which is called an "except" gate or inhibitory gate.

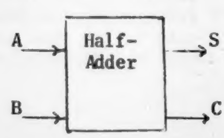
general routine -- Digital Computer Programming. A routine expressed in computer coding designed to solve a class of problems, specializing to a specific problem when appropriate parametric values are supplied.

generate -- Digital Computer Programming. To produce coding by assembling and modifying primitive elements; similar to generation of a line by a point, a plane by a line, etc.

generator -- Digital Computer Programming. A computer program which generates coding.

H: half-adder -- Circuits. A circuit having two output channels for binary signals (either zero or one) in which the output signals are related to the input signals according to the following table:

Input	Output
A B	S C
0 0	0 0
0 1	1 0
1 0	1 0
1 1	0 1



This circuit expresses in hardware a part of the functions necessary for binary addition. The letter S stands for "sum without carry"; the letter C stands for "carry". With two half-adders, and another circuit properly transferring the carry from one column to the next column, a circuit which will perform binary addition can be constructed.

hardware -- Computers. The mechanical, magnetic, electrical, and electronic devices from which a computer is constructed.

head -- Computers. Same as "magnetic head", a small electromagnet used for reading, recording or erasing polarized spots on a magnetic surface.

hold -- Computers. To retain the information contained in one storage device after copying it into a second storage device. Opposed to "clear".

holding beam — Computer Circuits. A diffuse beam of electrons for regenerating the charges stored on the dielectric surface of an electrostatic memory tube or cathode ray storage tube.

I: ignore (noun) -- Output Devices. A typewriter character indicating that no action whatsoever be taken. In the system of coding punched in Teletype of Flexowriter paper tape, the character "all holes punched" is an ignore.

infinity — Computers. Any number larger than the maximum number that the computer is able to store in any register. When such a number is calculated, the computer usually stops and signals an alarm indicating an overflow.

information -- 1. A set of marks or an arrangement of hardware that has meaning or that designates one out of a finite number of alternatives. 2. Any facts or data.

information word -- Computers. 1. Machine word. 2. The information content of a machine word. A machine word often includes the separating space between it and the following (or preceding) word.

inherited error -- Machine Computation. The error in the initial values, especially the error accumulated from the previous steps in a step-by-step integration.

input — Computers. Information transferred from secondary or external storage into the internal storage of the computer.

input block -- Computers. A section of the internal storage reserved for receiving and processing input data.

input equipment — Computers. The equipment used for taking information into a computer.

input unit -- Computers. The unit which takes into the computer information from outside the computer.

instruction — Computers. A machine word or a set of characters in machine language which directs the computer to take a certain action. More precisely, a set of characters which defines an operation together with one or more addresses (or no address) and which, as a unit, causes the computer to operate accordingly on the indicated quantities. Note: The term "instruction" is preferred by many to the terms "command" and "order"; "command" is reserved for electronic signals; "order" is reserved for uses in the meaning "sequence", as in "the order of the characters".

instruction code -- Digital Computer Programming. The system of symbols, names, and definitions of all the instructions that are directly intelligible to a given computer or a given executive routine.

integrator -- Analog Computers. A device whose varying output is proportional to the integral of a varying input magnitude.

interlace -- Computers. To assign successive memory location numbers to physically separated memory locations on a magnetic drum, for example, in such a way that access time to successive memory locations is greatly reduced.

internal memory -- Computers. The total memory or storage which is accessible automatically to the computer without human intervention. This equipment is an integral physical part of the computer and is directly controlled by the computer.

internal storage -- Computers. Same as internal memory, which see.

interpreter -- Digital Computer Programming. An executive routine which, as the computation progresses, translates a stored program expressed in some machine-like pseudo-code into machine code and performs the indicated operations, by means of subroutines, as they are translated. An interpreter is essentially a closed subroutine which operates successively on an indefinitely long sequence of program parameters (the pseudo-instructions and operands). It may usually be entered as a closed subroutine and left by a pseudo-code exit instruction.

interpreter code -- A code acceptable to an "interpreter", which see.

interpretive routine — Same as "interpreter", which see.

item -- 1. A separate piece of information; a separate particular. 2. Digital Computer Programming. A group of fields reporting information about a person or object. An example of an item is a punch card punched with employee's name in columns 1 to 12, employee number in columns 13 to 15, weekly rate of pay in columns 16 to 19, and other standard information about the employee in other columns.

J: jump — Digital Computer Programming. An instruction or signal which, conditionally or unconditionally, specifies the location of the next instruction and directs the computer to that instruction. A jump is used to alter the normal sequence in the control of the computer. Under certain special conditions, a jump may be caused by the operator's throwing a switch. See "transfer instruction".

K: key — Digital Computer Programming. A set of characters, forming a field, used to identify an item.

L: latency — Digital Computer Programming. Delay while waiting for information called for from the memory to be delivered to the arithmetical unit. More specifically, in a serial storage system, latency is the access time minus the word time. For example, latency is the time spent waiting for the desired memory location to arrive under the heads on a magnetic drum.

leapfrog test — Computer Operation. A program to test the internal operation of a computer,

characterized by the property that it performs a series of arithmetical or logical operations on one section of memory locations, then transfers itself to another section, checks to see that the transfer is correct, and then begins the series of operations over again. Eventually the checking program will have occupied every possible position in the memory and will begin again. The term "leapfrog" comes from the indicated jump in the position of the checking routine as seen on a monitoring cathode ray tube when it transfers itself.

library -- Digital Computer Programming. A collection of standard and fully tested programs, routines, and subroutines, by means of which many types of problems and parts of problems can be solved.

line-a-time printing -- Printing of a whole line of characters at one time, usually by means of one typebar (bearing all characters) for each character space in the line.

location -- Digital Computers. A storage position in the main internal storage or memory, storing one computer word; a storage register.

logic -- Computers. In the phrase "logic of the computer", same as "logical design", which see.

logical comparison -- Logic. The operation of comparing A and B; the result is 1 or yes if A is the same as B and 0 or no if A is not the same as B (or vice versa).

logical design -- Computers. Design that deals with the logical and mathematical interrelationships that must be implemented by the hardware.

logical operations -- Computers. The operations of comparing, selecting, making references, matching, sorting, merging, etc., where in essence ones and zeros corresponding to yeses and noes constitute the elements (yes-or-no quantities) being operated on.

loop -- Digital Computer Programming. Repetition of a group of instructions in a routine.

M: machine cycle -- Computers. The smallest period of time or complete process of action that repeats itself in order. In some computers, "minor cycles" and "major cycles" are distinguished.

machine language -- Computers. Information in the physical form which a computer can handle. For example, punched paper tape is machine language, while printed characters on paper are not usually machine language.

machine word -- Digital Computers. A unit of information of a standard number of characters, which a machine regularly handles in each transfer. For example, a machine may regularly handle numbers or instructions in units of 36 binary digits: this is then the "machine word".*5

magnetic core -- Computers. A form of storage where information is represented as the polarization north-south or south-north of a wire-wound magnetically permeable core, which may be straight, doughnut-shaped, etc.

magnetic drum -- Computers. A rapidly rotating cylinder, the surface of which is coated with a magnetic material on which information may be stored as small polarized spots.

magnetic head -- Computers. A small electromagnet used for reading, recording, or erasing polarized spots on a magnetic surface.

magnetic memory -- Computers. Any portion of the memory which makes use for storage of the magnetic properties of materials.

magnetic tape -- Tape made of paper, metal or plastic, coated or impregnated with magnetic material, on which polarized spots representing information may be stored.

magnetic wire -- Wire made of magnetic material on which polarized spots representing information may be stored.

major cycle -- Computers. In a memory device which provides access to storage positions one after another, the time interval between successive appearances of the same storage position. In other words, this is the time for one rotation of a magnetic drum or one recirculation of pulses in a delay line. It is an integral number of minor cycles.

malfunction -- Computers. A failure in the operation of the hardware of a computer.

marginal checking -- See *6

master clock -- Computers. The primary source of timing signals.

mathematical check -- A check making use of mathematical identities or other properties. For example, multiplication may be verified by the mathematical check that A multiplied by B is the same as B multiplied by A, the two multiplications being performed at different times and compared with each other. Frequently a small degree of discrepancy is acceptable; this is referred to as the tolerance.

mathematical logic -- Exact reasoning about nonnumerical relations using symbols that are efficient in calculation. Also called "symbolic logic".

mercury memory -- Digital Computers. Delay lines using mercury as the medium for storage of a circulating train of waves or pulses.

memory -- Computers.1. The units which store information in the form of the arrangement of hardware or equipment in one way or another. Same as "storage". 2. Any device into which information can be introduced and then extracted at a later time.

memory capacity -- The amount of information which a memory unit can store. It is often measured in the number of decimal digits or the number of binary digits which the memory unit can store. Other measures of memory capacity have also been defined.

mercury tank -- A container of mercury holding one or more delay lines storing information.

merge -- To produce a single sequence of items, ordered according to some rule (i.e., arranged in some orderly sequence), from two or more sequences previously ordered according to the same rule, without changing the items in size, structure, or total number. Merging is a special case of collating.

message -- A group of words, variable in length, transported as a unit.

microsecond -- A millionth of a second.

millisecond -- A thousandth of a second.

minimum access programming -- Digital Computer Programming. Programming in such a way that

minimum waiting time is required to obtain information out of the memory. Also called "minimum latency programming", or "forced coding".

minimum access routine -- Digital Computer Programming. In a computer with a serial memory, a routine coded with judicious arrangement of data and instructions in such a way that actual waiting time for information from the memory is much less than the expected random access waiting time.

minimum latency programming -- Same as "minimum access programming", which see.

minimum latency routine -- Same as "minimum access routine" , which see.

minor cycle -- Digital Computers. In a digital computer using serial transmission , the time required for the transmission of one machine word, including the space between words.

mistake -- Computers. A human error which results in an incorrect instruction in a program or in coding, an incorrect element of information, or an incorrect manual operation.

modifier -- Digital Computer Programming. A quantity, sometimes the cycle index, used to alter the address of an operand.

modify -- Digital Computer Programming. 1. To alter in an instruction the address of the operand. 2. To alter a subroutine according to a defined parameter.

modulo n check -- Computers. A form of check digits, such that the number of ones in each number A operated with is compared with a check number B carried along with A equal to the remainder of A when divided by n. For example, in a "modulo 4 check", the check numbers will be 0, 1, 2, or 3, and the remainder of A when divided by 4 must equal the reported check number B, or else an error has occurred.

N: non-erasable storage -- Storage media which cannot be erased and reused, such as punched paper tapes and punched cards.

non-volatile storage -- Storage media which retain information in the absence of power, such as magnetic tapes, drums, or cores.

notation -- Arithmetic. A manner of representing numbers. If quantities are written in the scale of notation n, then the successive positions of the digits report the powers of n. Thus 378 in the scale of 10 or decimal notation, means 3 hundreds, 7 tens, and 8. 1101 in the scale of 2, or binary notation, means 1 eight, 1 four, no twos, and 1 one. 764 in the scale of 8, or octal notation, means 7 sixty fours, plus 6 eights, plus 4.

numeric coding -- A system of coding or abbreviation in the preparation of machine language such that all information is reported in numbers. For example, ten places such as Boston, New York, Philadelphia, Washington, etc., may be reported as decimal digits 0, 1, 2, 3 ...., whereas in "alphabetic coding" alphabetic abbreviations BO, NY, PH, WA, ... would be acceptable to the machine.

O: octal digit -- One of the sumbols 0, 1, 2, 3, 4, 5, 6, 7 when used as a digit in numbering in the scale of eight.

octal notation -- Notation of numbers in the scale of eight. For example, the number 217 in this scale means 2 times 8 squared (2 x 64 = 128) plus 1 times 8, plus 7, which equals 143 in decimal notation. The number 217 in octal is equal to 010, 001, 111 in binary, each octal digit being changed directly into its binary equivalent. The octal notation is rather convenient in dealing with binary machines because octal numbers are easier for human beings to read than binary numbers, and yet the conversion is immediate.

odd-even check -- Use of a digit carried along as a check which is 1 if the total number of ones in the machine word is even, and which is 0 if the total number of ones in the machine word is odd, or vice versa.

one-address (adjective) -- Digital Computer Programming. Having the property that each complete instruction includes an operation and specifies the location of only one register in the memory. Also called "single-address".

on-line data reduction -- Reduction of data that is just as fast as the data flows into the reduction process.

open subroutine -- Digital Computer Programming. A subroutine inserted directly into a linear sequence of instructions, not entered by a jump. Such a subroutine must be recopied at each point that it is needed in a routine.

operand -- Computers. Any one of the quantities entering into or arising from an operation. An operand may be an argument, a result, a parameter, or an indication of the location of the next instruction.

operating ratio -- Computer Operation. The ratio obtained by dividing (1) the total number of hours of correct machine operation (including time when the program is incorrect through human mistakes) by (2) the total number of hours of scheduled computer operation including preventive maintenance. For example, if the computer is scheduled for three shifts totaling 120 hours in a week, and if "preventive maintenance" takes 12 hours, and "unscheduled down-time" amounts to 3 hours, then the "operating ratio" is 87½%.

operation code -- Digital Computer Programming. That part of an instruction which designates the operation of arithmetic, logic, or transfer to be performed.

operation number -- Digital Computer Programming. A number indicating the position of an operation or its equivalent subroutine in the sequence forming a program. When a problem is stated in pseudo-code, each step must sometimes be assigned an operation number.

operator -- Computers. The person who actually operates the computer, puts problems on, presses the start button, etc.

optimum programming -- Programming which is the best from some point of view. See "minimum access programming".

"or" circuit -- Circuits. A circuit which has two input lines and one output line, and which has the property that whenever a pulse is present on one or both of the input lines, a pulse is provided on the output line.

order -- 1. Sequence. 2. Instruction. -- Because of this possible confusion, the word "order" with the meaning "instruction" is avoided by many computer people.

output -- Computers. 1. Information transferred from the internal storage of a computer to

secondary or external storage. 2. Information transferred to any device outside of the computer.

output block -- Digital Computers. A segment of the internal storage reserved for receiving data to be transferred out.

output equipment -- Computers. The equipment used for transferring information out of a computer.

output unit -- Computers. The unit which delivers information outside the computer in acceptable language.

overflow -- Computers. In a counter or register, the production of a number which is beyond the capacity of the counter. For example, adding two numbers, each within the capacity of the registers holding them, may result in a sum beyond the capacity of the register that is to hold the sum: overflow.

P: pack -- Digital Computer Programming. To combine several different brief fields of information into one machine word, For example, the fields of an employee's pay number, weekly pay rate, and tax exemptions may be stored together in one word, each of these fields being assigned a different set of digit columns.

parallel operation -- Computers. The flow of information through the computer or any part of it using two or more lines or channels simultaneously.

parallel storage -- Computers. Storage in which all bits, or characters, or words are essentially equally available in space, without time being one of the coordinates. Parallel storage contrasts with serial storage. When words are in parallel, the storage is said to be parallel by words; when characters within words are dealt with simultaneously, not one after the other, the storage is parallel by characters.

parameter -- Digital Computer Programming. In a subroutine, a quantity which may be given different values when the subroutine is used in different parts of one main routine, but which usually remains unchanged throughout any one such use. To use a subroutine successfully in many different programs requires that the subroutine be adaptable by changing its parameters.

parity check -- Use of a digit (called the "parity digit") carried along as a check which is 1 if the total number of ones in the machine word is odd, and 0 if the total number of ones in the machine word is even. See "odd-even check".

patch -- Digital Computer Programming. A section of coding inserted into a routine (usually by explicitly transferring control from the routine to the patch and back again) to correct a mistake or alter the routine.

permanent memory -- Computers. Storage of information which remains intact when the power is turned off; for example, storage on a magnetic drum.

plotting board -- Computers. An output unit which plots the curves of one or more variables as a function of one or more other variables.

plugboard -- Punch Card Machines. A removable board holding many hundreds of electric terminals into which short connecting wire cords may be plugged in patterns varying for different programs for the machine. To change the program, one wired-up plugboard is removed and another wired-up plugboard is inserted. A plugboard is equivalent to a program tape which presents all instructions to the machine at one time. It relies on X-punches and other signals in the punch cards passing through the machine to cause different selections of instructions in different cases.

plug-in-unit -- A subassembly of tubes, resistors, condensers, diodes, etc., wired together, which is of a standard type and which as a whole can be plugged in or pulled out easily.

point -- Arithmetic. In a scale of notation, the position designated with a dot that marks the separation between the integral and fractional parts of the number. Called "decimal point" in the scale of 10 and "binary point" in the scale of 2.

post mortem (noun) -- Digital Computer Programming. A diagnostic routine which either automatically or when called for, prints out information concerning the contents of all or a specified part of the registers of the computer, after a problem tape has "died" on the computer. The purpose of a post mortem tape is to assist in the location of an error in coding the problem or in machine function.

precision -- Computation. The degree of exactness with which a quantity is stated, as contrasted with "accuracy", which is the degree of exactness with which a quantity is known or observed. The number of significant figures measures the precision of a number. For example, in "computer power required is 55.7843 kilowatts", the number is precise to six figures, but its accuracy certainly is much less.

prestore -- Digital Computer Programming. 1. To set an initial value for the address of an operand or a cycle index. 2. To store a quantity in an available or convenient location before it is required in a routine.

printer -- Computers. An output mechanism which prints or typewrites characters.

program (noun) -- Computers. 1. A precise sequence of coded instructions for a digital computer to solve a problem. Note: For this meaning, the term "routine" is preferred by some people. 2. A plan for the solution of a problem. A complete program includes plans for the transcription of data, coding for the computer, and plans for the effective use of the results.

program (verb) -- To make a program.

program parameter -- Digital Computer Programming. A parameter incorporated into a subroutine during computation. A program parameter frequently comprises a word stored relative to either the subroutine or the entry point and dealt with by the subroutine during each reference. It may be altered by the routine. It may vary depending on point of entry.

program register -- Digital Computers. The register in the control unit of the computer which stores the current instruction of the program and thereby completely controls the operation of the computer during the cycle of execution of that instruction. Same as "control register". Also called "program counter".

program step -- Computers. A step in a program, usually one instruction.

program tape -- Computers. The tape which contains the sequence of instructions to the computer for solving a problem.

program-sensitive error -- Computers. An error arising from unforeseen behavior of some circuits, discovered when a comparatively unusual combination of program steps occurs.

programmed checking — Computers. A system of checking whereby (1) before running any problem P a sample problem of the same type with known answer is run, and (2) mathematical or logical checks of operations, such as comparing A x B with B x A, are included in the program for P, and (3) reliance is placed on a very high probability of correctness rather than built-in error-detection circuits.

programmer -- A person who prepares sequences of instructions for a computer, without necessarily converting them into the detailed codes.

pseudo-code -- Digital Computer Programming. An arbitrary code, independent of the hardware of a computer, which must be translated into computer code if it is to direct the computer.

pseudo-random (adjective) -- Computation. Having the property of being produced by a definite calculation process, but at the same time satisfying one or more of the standard tests for statistical randomness.

pulse -- Circuits. In general, a sharp difference between the normal level of some medium corresponding to the average height of a wave and a high or low level of that medium corresponding to the crest or trough of a narrow wave; often, a sharp voltage change.

pulse code -- A set of pulses to which a particular meaning has been assigned; the binary representations of a character.

punch card -- Computers. A card of constant size and shape, suitable for punching in a pattern that has meaning, and for being handled mechanically. The punched holes are usually sensed electrically by wire brushes or mechanically by metal fingers.

punch card machinery — Machinery which operates with punch cards.

punched tape -- Paper tape punched in a pattern of holes so as to convey information.

punch position — In the case of 80-column punch cards, the position of a punch in a row on the card, denoting a decimal digit 0 to 9, or what are called an "X punch" (row 11), or a "Y punch" (row 12).

Q: quantity -- A positive or negative real number in the mathematical sense. Note: The term "quantity" is preferred by some computer people for referring to numeric data; the term "number" is preferred in the sense of integer or natural number, as in "the number of digits".

R: random access — Computers. Access to the memory or storage under conditions where the next register from which information is to be obtained is chosen at random. For example, access to names in the telephone book is "random access"; the next name that anyone is going to look up in the book may be almost anywhere in the book with roughly equal probability.

random access programming -- Programming a problem for a computer without regard to the time for access to the information in the registers called for in the program. Contrasted with "minimum access programming".

random number -- A number formed by a set of digits selected from a random sequence of digits. A sequence of digits is random when it is constructed by a process under which each successive digit is equally likely to be any of the n digits to the base n.

rapid memory -- Computers. The section of the whole memory from which information may be obtained the most rapidly.

read -- Computers. 1. To copy, usually from one form of storage to another, particularly from external or secondary storage to internal storage. 2. To sense the meaning recorded in arrangements of hardware.

read-around-ratio -- Digital Computers. In cathode-ray-tube storage, the number of times that information can be recorded or read or erased successively as an electrostatic charge on a single spot in the array, before the charge on surrounding spots in the array must be restored if not to be lost. This number is referred to also as the "read-around".

real time -- In solving a problem, a speed sufficient to give an answer in the actual time during which the problem must be solved. For example, in the case of a human being driving a motor car: at 30 miles an hour he can regularly solve nearly all his problems in real time; and at 100 miles an hour he will regularly fail to solve some of his problems in real time.

real time operation — Computer Operation. Solving problems in real time. More precisely, processing data in time with a physical process so that the results of the data-processing are useful in guiding the physical operation.

red-tape operations — Digital Computer Programming. Computer operations called for by a program which do not directly contribute to solving the problem; namely, arithmetical, logical, and transfer operations used in modifying the address section of other instructions, in counting cycles, in rearranging data, etc.

redundant check -- Computers. A check which uses extra digits in machine words, but not complete duplication, to help detect malfunctions and mistakes.

reel -- A spool of tape, generally magnetic tape.

reference record -- Digital Computer Programming. An output of a compiler that lists the operations and their position in the final specific routine, and contains information describing the segmentation and storage allocation of the routine.

regenerate -- Digital Computers. In the operation of electrostatic storage, to restore information currently held in a cell on the cathode ray tube screen in order to counteract fading and disturbances.

register -- Computers. The hardware for storing one machine word.

relative address — Digital Computer Programming. A label used to identify the position of a memory location in a routine or subroutine. Relative addresses are translated into absolute addresses by adding some specific "reference" address, usually the address at which the first word of the routine is stored. For

example, if a relative address instruction specifies an address n and the address of the first word of the routine is k, then the absolute address of the memory location is n+k.

relative coding — Digital Computer Programming. Coding in which all addresses refer to an arbitrarily selected position, or in which all addresses are represented symbolically.

repetition rate -- Computers. The fastest rate of electronic pulses usually used in the circuits of the machine.

reproducer — Punch Card Machines. A punch card machine that punches cards to agree as may be specified with other cards.

rerun — Digital Computer Programming. To run a a program or a portion of it over again on the computer.

rerun point -- Digital Computer Programming. One of a set of planned-for points in a program such that if an error is detected in between two such points, to rerun the problem it is only necessary to go back to the last rerun point, instead of returning to the start of the problem. Rerun points are often three to five minutes apart so that very little computer time is required for a rerun. All information pertinent to a rerun is available in standby registers during the whole time from one rerun point to the next.

rerun routine -- Digital Computer Programming. A routine designed to be used in the wake of a malfunction or a mistake to reconstitute a routine from the last previous rerun point.

reset -- To return a register to zero or to a specified initial condition.

resolver -- Analog Computers. A device for resolving a vector into two mutually perpendicular components.

restore — Computers. To return a cycle index, a variable address, or other computer word to its initial value. See also "reset".

rewind — Computers. To return a magnetic tape to its beginning.

roll out (verb) — Computers. To read out of a register or counter by the following process: add to the digits in each column simultaneously; do this 10 times (for decimal numbers); when the result in each column changes from 9 to 0, issue a signal.

rollback — Digital Computer Programming. Same as "rerun", which see.

round off — Computation. To change a more precise quantity to a less precise one, usually choosing the nearest less precise one; see "precision".

rounding error -- Computation. The error resulting from dropping certain less significant digits of a quantity, and applying some adjustment to the more significant digits retained.. Also called "round-off error". A common round-off rule is to take the quantity to the nearest digit. Thus pi, 3.14159265..., rounded to four decimals is 3.1416. Note: Alston S. Householder suggests the following terms: "initial errors", "generated errors", "propogated errors" and "residual errors". If x is the true value of the argument, and x^* the quantity used in computation, then, assuming one wishes $f(x)$, $x-x^*$ is the initial error; $f(x) - f(x^*)$ the propagated error. If f_a is the Taylor, or other, approximation utilized, then $f(x^*) - f_a(x^*)$ is the residual error. If f^* is the actual result then $f_a - f^*$ is the generated error, and this is what builds up as a result of rounding.

routine — Digital Computers. 1. A sequence of operations which a digital computer may perform. 2. The sequence of instructions determining these operations. 3. A set of coded instructions arranged in proper sequence to direct the computer to perform a desired operation or series of operations. See also "subroutine" and "program".

run (noun) -- Computers. 1. One performance of a program on a computer. 2. Performance of one routine, or several routines during which the human operator does not have to do anything.

S: scale (verb) -- Computation. To change the scale (that is, the units) in which a variable is expressed so as to bring it within the capacity of the machine or program at hand.

scale factor -- Computation. One or more factors used to multiply or divide quantities occurring in a problem and convert them into a desired range, such as the range from plus one to minus one.

screen — Circuits. In an electrostatic storage tube, the surface where electrostatic charges are stored. In a pentode, one of the grids.

secondary storage -- Computers. Storage that is not an integral part of the computer but directly linked to and controlled by the computer; for example, magnetic tapes.

segment (noun) -- Digital Computer Programming. In a routine too long to fit into internal storage, a part short enough to be stored entirely in the internal storage yet containing the coding necessary to call in and jump automatically to other segments. Routines which exceed internal storage capacity may be automatically divided into segments by a compiler.

segment (verb) -- To make segments.

sense (verb) -- Computers. 1. To determine the arrangement of some element of hardware, especially a manually-set switch. 2. To read holes punched in paper.

sentinel -- Digital Computer Programming. A symbol marking the beginning or the end of some piece of information such as a field, item, block, tape, etc. a tag.

select — Logic. To take A if the report on a certain condition is yes, and take B if the report is no.

selector -- Punch Card Machines. A mechanism which reports a condition and causes a card or an operation to be selected accordingly.

sequence (verb) -- Logic. To select A if A is greater than or equal to B, and select B if A is less than B, or some variation of this operation.

sequence checking routine — A checking routine which checks on every instruction executed, printing certain data. It may be designed to print out the coded instruction with addresses, and the contents of each of several registers for each instruction as it is executed. Or it may be designed to print out only selected data, such as transfer instructions when they occur, and the quantity actually transferred. Many variations are possible. A good flexible sequence checking routine will provide for several variations in itself.

sequence-control tape -- Program tape. (obsolescent term).

sequential control -- Computers. The manner of control of a computer in which instructions to it are set up in a sequence and are fed in that sequence to the computer during the solution of a problem.

sequencer -- Punch Card Machines. A mechanism which will put items of information in sequence. It will determine if A is greater than, equal to, or less than B, and will accordingly route cards containing A and B into a pocket at different times.

serial -- Computers. Handled one after the other in a single piece of equipment.

serial operation -- Computers. The flow of information through the computer or in any part of it using only one line or channel at a time. Contrasted with "parallel operation."

serial storage -- Computers. Storage in which time is one of the coordinates used to locate any given bit, character, or (especially) word. Storage in which words, within given groups of several words, appear one after the other in time sequence, and in which access time therefore includes a variable latency or waiting time of zero to many word-times, is said to be serial by word. Storage in which the individual bits comprising a word appear in time sequence is serial by bit. Storage for coded-decimal or other non-binary numbers in which the characters appear in time sequence is serial by character; for example, magnetic drums are usually serial by word but may be serial by bit, or parallel by bit, or serial by character and parallel by bit, etc.

serial transfer -- Computers. A system of data transfer in which the characters of an element of information are transferred in sequence over a single path in consecutive time positions.

service routine -- Digital Computer Programming. A routine designed to assist in the actual operation of the computer. Tape comparison, block location, certain post mortems, and correction routines fall in this class.

shift -- To move the characters of a unit of information columnwise right or left. In the case of a number, this is equivalent to multiplying or dividing by a power of the base of notation (usually ten or two). This is regularly performed as a special rapid operation, much faster than usual multiplication or division.

sign digit -- A one or a zero used to designate the algebraic sign of a quantity plus or minus.

significant digits -- See *7

simulation -- The representation of physical systems by computers, models, and associated equipment.

single-address -- Same as "one-address", which see.

skip (noun) -- Digital Computer Programming. An instruction to proceed to the next instruction; a "blank" instruction.

slow memory -- Computers. Sections of the memory from which information may be obtained automatically but not at the fastest rate of the several sections.

sonic delay line -- A delay line which uses pulses of motion of the molecules of the medium, (sound pulses), in contrast with an electrical delay line which uses electrical pulses in a wire or in an assembly of coils and capacitors.

sort -- To arrange items of information according to rules dependent upon a key or field contained by the items, such as previously chosen classes of items.

sorter -- Punch Card Machines. A machine which sorts cards according to the punches in a specified column of the card.

specific coding -- Digital Computer Programming. Coding in which all addresses refer to specific registers and locations.

specific routine -- Digital Computer Programming. A routine expressed in specific computer coding designed to solve a particular mathematical, logical, or data-handling problem.

standardize -- Computation. To adjust the exponent and coefficient of a floating-point result so that the coefficient lies in the prescribed normal range.

static storage -- Computers. Storage such that information is fixed in space and available at any time provided the power is on; for example, flip-flop, electrostatic, or coincident-current magnetic-core storage.

static subroutine -- Digital Computer Programming. A subroutine which involves no parameters other than the addresses of the operands. This is a subroutine which requires only the relative addresses of the operands, their insertion, and its transformation from relative to specific coding.

storage -- Computers. 1. The unit which holds or retains items of information. 2. Any device into which information can be introduced, held, and then extracted at a later time. The mechanism or medium in which the information is stored need not form an integral part of a computer. Synonyms: memory, store (in English usage).

storage capacity -- Same as "memory capacity", which see.

storage operation -- One of the operations of reading, transferring, storing, or writing information.

storage register -- A register in the memory or storage of the computer, in contrast with a register in one of the other units of the computer.

storage tube -- Same as "electrostatic storage tube", which see.

store (noun) -- Same as "storage", which see.

store (verb) -- To transfer a piece of information to a device from which the information unaltered can be obtained at a later time.

subprogram -- A part of a program.

subroutine -- Computers. 1. A short or repeated sequence of instructions for a computer to solve a part of a problem; a part of a routine. 2. The sequence of instructions necessary to direct the computer to carry out a well-defined

mathematical or logical operation; a subunit of a routine. A subroutine is often written in relative or symbolic coding even when the routine to which it belongs is not.

summary punch -- Punch Card Machines. A punch card machine which may be attached by a many-wire cable to another machine (for example, a tabulator), and which will punch out on a card the information produced or calculated or summarized by the other machine.

summation check -- Computer Operation. A redundant check in which groups of digits are summed, usually without regard for overflow, and that sum checked against a previously computed sum to verify accuracy of computation.

symbolic address -- Digital Computer Programming. A label chosen to identify a particular word, function or other information in a routine, independent of the location of the information, within the routine. Also called "floating address".

symbolic logic -- Exact reasoning about nonnumerical relations using symbols that are efficient in calculation. A branch of this subject known as Boolean algebra has been of considerable assistance in the logical design of computing circuits. Also called "mathematical logic".

synchronous computer -- An automatic digital computer where the performance of all ordinary operations starts with equally spaced signals from a master clock.

T: tabulator -- Punch Card Machines. A punch card machine which takes in punch cards and instructions and produces lists, totals, and tabulations of the information on separate forms or on continuous paper.

tag -- Digital Computer Programming. A unit of information, whose composition differs from that of other members of the set so that it can be used as a marker or label; a sentinel.

tank -- A unit of delay-line storage, usually of mercury and operating acoustically, containing a set of channels each forming a separate recirculation path.

tape -- Computers. Magnetic tape or punched paper tape, sometimes other kinds of tape.

tape feed -- A mechanism which will feed tape to be read or sensed by the machine.

temporary storage -- Computers. Internal storage locations reserved for intermediate and partial results.

test routine -- Digital Computer Programming. A routine designed to show that a computer is functioning properly.

three-address (adjective) -- Digital Computer Programming. Having the property that each complete instruction includes an operation and specifies the location of three registers.

torque amplifier -- Analog Computers. A device possessing input and output shafts and supplying work to rotate the output shaft in positional correspondence with the input shaft without imposing any significant torque on the input shaft.

track -- Computers. In a magnetic drum or magnetic tape, a single path containing a set of pulses.

transcribe -- To copy, with or without translating, from one external storage medium to another.

transfer (verb) -- 1. To transfer data; to copy, exchange, read, record, store, transmit, transport, or write data. To transfer does not modify the information. 2. To transfer control of a computer.

transfer (noun) -- An act of transferring.

transfer check -- A check that an operation of transferring has been correctly carried out.

transfer instruction -- Digital Computer Programming. An instruction or signal which conditionally or unconditionally specifies the location of the next instruction and directs the computer to that instruction. See "jump".

transform -- Digital Computer Programming. To change information in structure or composition without significantly altering the meaning or value; to normalize, edit, or substitute.

translate -- Computers. To change information from one language to another without significantly affecting the meaning.

trouble-location problem -- A test problem whose incorrect solution supplies information on the location of faulty equipment; used after a check problem has shown that a fault exists.

trouble-shoot -- To search for the cause for a coding mistake or a computer malfunction in order to remove it.

truncate -- Computation. To drop digits of a number or terms of a series thus lessening precision. See "precision". For example, the number pi "3.14159265...." is "truncated" to three figures in "3.14".

truncation error -- Computation. The error resulting from the use of only a finite number of terms of an infinite series, or from the approximation of operations in the infinitesimal calculus by operations in the calculus of finite differences.

trunk -- A path over which information is transferred; a bus.

twin check -- A continuous check of computer operations achieved by duplication of the hardware to perform them together with automatic comparison.

two-address (adjective) -- Digital Computer Programming. Having the property that each complete instruction includes an operation and specifies the location of two registers, usually one containing an operand and the other containing the result of the operation.

U: unconditional transfer -- Digital Computer Programming. In a digital computer which ordinarily obtains its instructions serially from an ordered sequence, an instruction which causes the following instruction to be taken from an address which is not the next one in the sequence.

unwind -- Digital Computer Programming. To code explicitly, at length and in full, all the operations of a cycle, in such a way as to eliminate all red-tape operations. Unwinding may be performed automatically by the computer during assembly, generation, or compilation.

unpack -- Digital Computer Programming. To separate packed items of information each into a separate machine word. See "pack".

V: validity -- Computation. Correctness, especially the degree of closeness by which an iterated approximation approaches the desired correct result.

variable cycle operation -- Computer Operation. Operation of a computer whereby any cycle of operation may be longer or shorter than the average. This is the kind of operation in an "asynchronous computer".

verifier -- 1. Punch Card Machines. A punch card machine operated manually which reports by signals whether punched holes have been inserted in the wrong places in a punch card or have not been inserted at all. 2. Computers. An auxiliary device on which a previous manual transcription of data can be verified by comparing a current manual transcription of it character-by-character during the current process.

verify -- 1. To check, usually with an automatic machine, one typing or recording of data against another in order to minimize the number of human errors in the data transcription. 2. In preparing information for a computer, to make certain that the information as prepared is correct.

volatile memory -- Computers. Memory or storage having the property that if the power is turned off, the information vanishes; delay line memory, electrostatic storage tubes.

volatile storage -- Same as "volatile memory".

W: Williams tube -- Digital Computers. A cathode-ray tube for electrostatic storage of information of the type designed by F.C. Williams of the University of Manchester, England.

word -- Digital Computers. An ordered set of characters which has at least one meaning, and is stored and transferred by the computer circuits as a unit. *8
Ordinarily, a word has a fixed number of characters, and is treated by the control unit as an instruction, and by the arithmetic unit as a quantity. For example, a computer may regularly handle numbers or instructions in units of 36 binary digits.

word-time -- Digital Computers. Especially in reference to words stored serially, the time required to transfer a machine word from one storage device to another.

working storage -- Digital Computers. A portion of the internal storage reserved for data upon which operations are currently being performed, and for intermediate and partial results, like a work-sheet in pencil and paper calculation.

write -- Digital Computers. 1. To copy information usually from internal to external storage. 2. To transfer information to an output medium. 3. To record information in a register, location, or other storage device or medium.

Z: zero -- Digital Computers. The computer's conceptions of zero. Note: The computer may provide for two zeros. Positive binary zero is represented by the absence of digits or pulses in a word. Negative binary zero in a computer operating with ones' complements may be represented by a pulse in every pulse position in a word. In a coded decimal computer, decimal zero and binary zero may not have the same representation. In most computers, there exist distinct and valid representations both for positive and for negative zero.

zero-address instruction -- Digital Computers. An instruction specifying an operation in which the location of the operands are defined by the computer code, so that no address need be given explicitly.

zero-access storage -- Digital Computers. Storage for which the latency or waiting time is always negligible.

zero-suppression -- The elimination of non-significant zeros to the left of the integral part of a quantity before printing is begun. To suppress these zeros is one of the operations in editing.

zone -- 1. Punch Cards. Any of the three top positions 12, 11, and 0. In these zone positions a second punch can be inserted, so that with punches in the remaining positions 1 to 9, enough two-punch combinations are obtained to represent alphabetic characters. 2. Digital Computers. A portion of internal storage allocated for a particular purpose.

- END -

Forum

GLOSSARY TRANSLATION INTO ITALIAN

I. From Dr. Paolo Sardi, Turin, Italy, November 15:
Reference is made to the Glossary of Terms in the Field of Computers and Automation included in the December, 1954, issue of your magazine. This is of very service because it could be used to standardize the terminology in the above new field.

Inasmuch as I deem it useful that also in Italy those concerned with such an important application field adopt a terminology most adjusted to yours, I beg to apply for an authorization by you to have this glossary translated and published in some next issue of an Italian technical magazine I shall take care to send you a copy of. Of course the source will be shown therein. I want to inform you that such translation might be included in either the Schede Perforate e Calcoli Elèttronici or the Tecnica ed Organizzazione magazine.

II. From the Editor, December 5:
We are glad to give you permission to translate our computer glossary into Italian, and we hope that after it is translated and published you will be able to send us two copies.

III. From Dr. Sardi, Turin, December 12:
I thank you very much indeed for authorizing me to get the translation and issue of the Glossary of Terms in the Field of Computers and Automation.

Since such a translation is going to take a certain lot of time, I will send you the two copies you ask for as soon as possible.

IV. Note by the Editor:
Although standardization is often desirable, we believe that it should come about mainly as a result of choice by individuals rather than through decrees by groups, in the same way as language in general evolves. / If other people desire to translate the glossary into other languages, we shall be pleased to grant permission on request.

FINDING OUT THAT SOMETHING EXISTS

NEIL D. MACDONALD
Assistant Editor, "Computers and Automation"
(Reprinted with changes from "Computers and Automation", Vol. 4, No. 11, Jan. 1955)

Often when one investigates a subject, the crucial knowledge is finding out that something exists or can be done. For instance, if you are investigating from whom to buy an automatic inventory machine, the crucial knowledge is finding out who offers such machines for sale. A man who has never heard that the ABC Company offers automatic inventory machines for sale is hardly in a position to consider buying from them.

To supply this crucial knowledge of existence in the field of computers and automation we have published various kinds of rosters and reference lists; there are now more than a dozen kinds.

Yet one reader, whom we shall call J. Moines since that is not his real name, has said to us "You should not publish this valuable information for so little; you should restrict it, give it only to advertisers perhaps, keep it for your own advantage." We don't agree with Mr. Moines. Our purpose as a magazine is to be as useful as we can be; and we believe these rosters and lists help the men in the field.

We published the remarks of Mr. Moines, and we received an interesting reply from the office manager of a rubber company. He referred to "the question arising from your difference of opinion with a certain J. Moines", and said:

"I heartily support your position -- your publication has been of extreme value to me and my staff. And I am sure that the same position will be taken by all of your subscribers who have problems similar to ours... Early last spring, our management asked us to begin a program of aggressive research aimed at as high a degree of office mechanization as practicable."

We hope that the reference information we publish is useful to many men in the computer field. And since there are many kinds of reference information published in the magazine, here we print a guide to fourteen kinds of such information. In this way we can make it easier for our readers to find information they may desire.

Organizations

Who are the companies in the computer field, and what do they make?

The answer to this question is the reason that this magazine is in existence. For we began in September 1951 to issue a purple dittoed list of companies and other organizations (government agencies, university laboratories, etc.) making or developing automatic computing machinery and related items. This has now become the "Roster of Organizations in the Computer Field". The definition of the territory now included is: organizations making or developing computing machinery or data-processing machinery, or systems, or components and services significantly related to the computer field.

The last cumulative listing was published in the issue of December, 1955, vol. 4, no. 12, and it contains over 300 organizations. This compares with a year ago, when the roster contained 230 organizations. From time to time, we bring this Roster up to date.

A typical entry is the following one:

Remington Rand Univac Division of Sperry Rand Corporation, 315 4th Ave., New York 10, N.Y. / Spring 7-8000 / and elsewhere / entry checked
Digital computers (Univac System, Univac Scientific, Univac File-Computer, Univac 120, and Univac 60 Punched Card Electronic Computers). Analog computers; special purpose computers. Converters: card to tape, punched paper tape to magnetic tape, and magnetic tape to punched paper tape. High speed printers, servomechanisms, magnetic drum storage systems, input and output devices. Punched card tabulating equipment. Large size (over 6000 employees; 2500 on computers) Long established. Interested in digital and other computers. Research, manufacturing, selling, consulting, and problem-solving activities.

Who are the companies or organizations which provide computing services, using at least some kind of automatic computer?

These organizations, so far as we know them are listed in a "Roster of Automatic Computing Services". If any service organization has an IBM 604 (electronic calculating punch)

or any more capacious computing equipment, either analog or digital, we desire to include that organization in this list.

The latest cumulative "Automatic Computing Services -- Roster" was published in "Computers and Automation", December, 1955, vol. 4, no.12, and contains 49 organizations. A typical entry, with abbreviations eliminated, is:

> Burroughs Corporation, Electronic Instrument Div., 1209 Vine St., Philadelphia, Pa. / digital computing service / digital computer UDEC II / unrestricted (as to clients)

Computing Machinery and Automation

What are the types of automatic computing machinery?

It is sensible to recognize at this time at least 38 different classes of automatic machinery for handling information. They range through accounting-bookkeeping machines, game-playing machines, toll recording equipment, vending machines, etc., not to mention the obvious two classes, analog computers and digital computers. It is desirable to keep in mind how diverse is the new field of automatic machinery for handling information, and so we publish a reference list.

The last cumulative listing "Automatic Computing Machinery — List of Types" appears in the December 1955 issue, vol. 4, no. 12.

A typical entry is:

> Inventory machines, which will store as many as ten thousand totals in an equal number of registers, and which will add into, subtract from, clear, and report the contents of any called-for register (these machines apply to stock control, to railroad and airline reservations, etc.).

How many models of automatic computers are there, and which are they?

There are over 170 automatic computers, nearly all of them constructed since 1944. They range from ABC and Arra to X-RAC and Zuse Model 5. They are listed in "Roster of Automatic Computers"; and the latest information we have published is contained in:

> "Roster of Automatic Computers" (cumulative), vol. 4, no. 2, Feb. 1955

> "Roster of Automatic Computers -- Supplement", vol. 4, no. 4, April, 1955

A typical entry (eliminating the abbreviations) is:

> ABC (Automatic Binary Computer) / made by the Air Force Cambridge Research Center, Cambridge, Mass.; located there / general purpose; electronic digital computer; medium size; quantity, one.

If models of automatic computers are examples of automatic computing machinery, what are similar examples of automation?

This is not nearly so definite a question, of course, as the last one, but we have tried to answer it by constructing somewhat the same sort of list for automation. The first such cumulative listing was "Automation — List of Outstanding Examples", which appeared in the July 1954 issue, vol. 3, no. 6, p. 13. It contained 16 examples, of which one was:

> Ordnance: shells for explosives / W. F. and John Barnes Co., Rockford, Ill. / Factory makes shells from start to finish without touching by human hands.

Supplements to this listing have been published from time to time in Forum.

What are the commercial computers, and how many are there in use?

Although this is a difficult question to answer because of industrial competitive procedures, we have published one piece of reference information seeking to answer it. This was "Automatic Computers — Estimated Commercial Population" (cumulative, information as of December, 1954). It appeared in the March, 1955, "Computers and Automation", vol. 4, no. 3; it listed the number of machines installed and in use according to announcements made by various manufacturers.

A typical entry taken from the listing as published at that time is:

> Underwood Corp. (ELECOM 100, 120, 200) -- seven installed and in use

---

What are the types of components of automatic machinery?

As one becomes familiar with automatic machinery for handling information, i.e., auto-

matic computing machinery or data processing machinery, one finds out that there is a relatively small class of components. A list of about 50 of them appears in "Components of Automatic Computing Machinery -- List of Types" in the December 1955 issue, vol. 4, no. 12. A typical example of a type of component is:

> "Matrix printer, which forms each character by a pattern of dots."

Products and Services

What are the products and services in the computer field offered for sale or rent?

To supply information about such products and services and their description, uses, price, and suppliers, we published in the June, 1955, Computer Directory issue of "Computers and Automation", vol. 4, no. 6, a section entitled "The Computer Field: Products and Services for Sale"; it contained about 600 entries in about 60 classifications.

A sample entry, eliminating abbreviations, follows:

> Remington Rand, Inc., 315 4th Ave., New York 10, N. Y. / Tape-to-Card converter, Type 308-5 / Description: Key punch electrically connected to a 5 channel code paper tape reader so that information is read, decoded and punched into 90-column tabulating card; 420 characters per minute; may be used as standard punched card accounting machine key punch / Use: convert paper tape information to punched cards; also used with Univac/ Rental $70 per month; sale $5075; price subject to tax where applicable.

Words

What are the special terms used in the field of computers and automation, and what do they mean?

This is a question in which we have been much interested ever since the purple ditto list which we first published turned into the photooffset magazine which we now publish. For the meanings of the special terms of a field constitute a most important clue to the important information in that field; they point out the key ideas. Several glossaries, and a number of discussions of problems of glossary-making were published in "Computers and Automation" up to December, 1954.

The last glossary published in "Computers and Automation" was in the December, 1954, issue. It contained definitions of over 400 terms and expressions. In this glossary the editors did not attempt to establish by decree the meanings of terms, but simply to report meanings and usages.

To our surprise we have received no discussion of terms and glossaries during the past year. It is as if the vocabulary of the computer field had temporarily reached a relative stability. So in this issue we reprint the glossary of December, 1954, with only a few changes. Examples of some of the entries are:

> biquinary notation -- Numbers. A scale of notation in which the base is alternately 2 and 5. For example, the number 3671 in decimal notation is 03 11 12 01 in biquinary notation; the first of each pair of digits counts 0 or 1 units of five, and the second counts 0, 1, 2, 3, or 4 units. For comparison, the same number in Roman numerals is MMMDCLXXI. Biquinary notation expresses the representation of numbers by the abacus, and by the two hands and five fingers of man; and has been used in some automatic computers.

> cybernetics -- 1. The study of control and communication in the animal and the machine. 2. The art of the pilot or steersman. 3. The comparative study of complex information-handling machinery and the nervous systems of the higher animals including man in order to understand better the functioning of brains.

> magnetic core -- Computers. A form of storage where information is represented as the polarization north-south or south-north of a wire-wound magnetically permeable core, which may be straight, doughnut-shaped, etc.

Information and Publications

What about books, magazines, and other publications in the field of computers and automation?

From time to time we publish a list of books and other publications related to computers and automation with short notes about them. A current example of entries in "Books and Other Publications" appears in this issue, January 1956, vol. 5, no. 1. The previous listing appeared in the September 1955 issue, vol. 4, no. 9. Other lists have appeared from time to time in various issues. The information has not so far been cumulated. Also, some of the articles and papers that we publish contain bibliographies: a notable example appears in the paper by Ned Chapin in the September 1955 issue, "Publications for Business on Automatic Computers: A Basic List".

Finding Out That Something Exists

In many issues from July 1953 on have appeared "Patents", or "New Patents", a listing of patents related to computing machinery, compiled by Hans Schroeder and Raymond R. Skolnick. Examples of entries appear elsewhere in this issue. The information has not so far been cumulated.

We have also printed "Magazines Related to Computers and Automation -- Roster". The last cumulative listing appeared in the December 1955 issue, vol. 4, no. 12. A typical entry, eliminating abbreviations, is:

> Scientific American / monthly / published by Scientific American, Inc., 2 West 45 St., New York 36, N. Y. / emphasis: ideas and developments in all phases of science, reported for educated men in other specialties / directed to technical management; paid-for; annual subscription \$5.00/ circulation about 120,000 / contains advertising / Occasional articles on computers and automation.

We have begun printing the titles and abstracts of papers given at meetings devoted to automatic computing machinery. A recent example was the printing in the November 1955 issue of "Computers and Automation", vol. 4, no. 11, of the titles and abstracts of approximately 115 papers given at the meeting of the Association for Computing Machinery, Philadelphia, Sept. 14 to 16, 1955.

People

Who are the people in the computing machinery field, what are they like, what are they interested in, and what do they do?

The answer to this question constitutes another kind of reference information which we have published. This is a "Who's Who in the Computer Field". The second edition, cumulative, was published in the June 1955 "Computer Directory" issue, vol. 4, no. 6. It contained about 7500 entries; of these about 2600 were full entries and the remainder (for lack of information) were brief entries showing only name and locality. A supplement appeared in the October 1955 issue, vol. 4, no. 10. A typical full entry, eliminating abbreviations, follows:

> Householder, Alston S. / Chief, Mathematics Panel, Oak Ridge National Laboratories, P. O. Box P, Oak Ridge, Tenn. / interested in mathematics / born 1904; graduate of University of Chicago, entered computer field in 1948; occupation, mathematician; published "Principles of Numerical Analysis" / information as of 1955

We, the editors of "Computers and Automation", desire to publish reference information which will be of "extreme value" to our readers, information that can hardly be obtained in any other way. We shall be glad to have comments, suggestions and criticisms from any of our readers for this purpose.

- END -

Automatic Coding Techniques

(continued from page 11)

ing to a pre-stored job sequence.

(3) The setting of program alteration switches via a punched card.

(4) The computation of a tape input-output set-up for each job. This takes into account the following:

  (a) requirements for input and output tapes

  (b) the number of tape units available (operable)

  (c) The optimum order in which alternating tape units are assigned

  (d) The optimum physical arrangement of these alternating units.

(5) The printing out of this set-up.

(6) The checking of input tape mounting for proper type, proper cycle number when it was produced as output, and proper sequence.

(7) The checking of all tapes mounted to receive output to guarantee that they do not contain wanted information.

(8) The printing of output tape labels and the identification of the tapes.

(9) A system for communicating the current physical tape unit assignment to the specific program.

It is hoped that all this can be accomplished with one tape unit, perhaps 10-15 drum sections and a wee small area of high-speed memory, less than 500 characters. My guess is that the drum is rather essential, as this philosophy applies to the 702-705. Anybody who lacked the foresight to order a drum would most certainly not be interested in this routine anyway.

I would very much appreciate your comments and suggestions, especially an evaluation of the worth of the thing in relation to the amount of effort required to realize it.

- END -

BOOKS AND OTHER PUBLICATIONS

JEWELL BOWN

(List 18, "Computers and Automation", Vol. 5, No. 1, Jan. 1956)

This is a list of books, articles, periodicals, papers, and other publications which have a significant relation to computers or automation, and which have come to our attention. We shall be glad to report other information in future lists, if a review copy is sent to us. The plan of each entry is: author or editor / title / publisher or issuer / date, publication process, number of pages, price or its equivalent / a few comments. If you write to a publisher or issuer, we would appreciate your mentioning the listing in COMPUTERS AND AUTOMATION.

Society of Actuaries, Committee on New Recording Means and Computing Devices / Current Status of Magnetic Tape as a Recording and Data Processing Medium / Society of Actuaries, 208 S. LaSalle St., Chicago 4, Ill. / June 1955, printed, 112 pp., cost?

This report is a summary of the Committee's findings on the characteristics of record-keeping techniques employing magnetic tape. Part I is entitled "Characteristics of magnetic tape and the equipment required for its use"; Part II deals with current and proposed life insurance company procedures employing magnetic tape equipment; Part III considers miscellaneous related considerations such as internal control and auditing, premium accounting, serial and random needs, etc. Three appendices contain information on programming, comparative handling of death claims, and an example of a magnetic-tape record-keeping system.

June, Stephen A., and others / The Automatic Factory / Instruments Publishing Company, Pittsburgh 12, Pa. / 1955, printed, 88 pp., cost?

This is the publication of a research paper written by a group of seven students at the Harvard Graduate School of Business Administration. Chapters include: The Automatic Factory in Perspective; Mechanization vs. the Automatic Factory; Contemporary Automaticity (in automobile and four other plants); Costs; Social Implication, etc.; Appendix I is a cost determination of Project Tinkertoy, an automatic system for manufacturing electronic circuits using ceramic wafers and printed circuits developed by the National Bureau of Standards. Tables, charts and illustrations are included.

Bardell, P. R. / Magnetic Materials in the Electrical Industry / Philosophic Library, Inc., 15 East 40 St., New York 16, N. Y. / 155, printed, 288 pp., $10.00

This is a British textbook "intended to be helpful to senior students in physics and electrical engineering and to physicists and engineers in industry". After a discussion of the influence of magnetic theory on the development of materials, subsequent chapters deal with the historical development, application and testing of permanent magnets and of soft magnetic materials. Further chapters are devoted to special devices such as sound recorders, non-destructive testers, transductors, and transducers. Also included are a glossary of terms and units, tables showing the properties of materials, and a note explaining magnetic terminology and units.

Allendoerfer, C. B., and C. O. Oakley / Principles of Mathematics / McGraw-Hill Book Company, Inc., 330 West 42 St., New York 36, N. Y. / 1955, printed, 448 pp., $5.00

This text is a new approach towards the basic curriculum in mathematics, along lines emphasizing remarkable recent advances in mathematics. Emphasis is placed upon understanding methods of mathematical reasoning, basic mathematical ideas, and the reasons behind mathematical processes. The first five chapters are entitled: Logic; The Number System; Groups; Fields; Sets and Boolean Algebra. The following chapters cover statistics and probability, in addition to the more usual material on functions, analytic geometry and calculus. In the treatment, many of the standard topics are treated in abbreviated form, but the concepts are emphasized. Each process is illustrated with a worked example, and exercises and problems, both theoretical and computational in character, are included. The text is designed for students having a prior course in intermediate algebra.

Remington Rand, staff of / Automatic Coding for the Univac Scientific System (A Progress Report), Programmer's Reference Manual / Remington Rand, 315 Fourth Ave.,

New York 10, N. Y. / 1955, photooffset, 35 pp., free

This manual is divided into three sections. The first is entitled "Univac Scientific 'Compile-Interpreters'" and is a review of some of the general concepts associated with current developments of compiler techniques for the Univac Scientific System. The second section describes the "Compile-Interpreter,I,i", which is called an "executive program-facility" and which "interprets", in the course of execution of a computer program, references to "file-items" filed in magnetic drum storage, thereby effecting "compilation" of the item into high-speed storage in a form appropriate for program execution. The third section contains "program schema and code".

Hunter, George Truman, and Graham M. Clark / "Electronic Data-processing Machines" reprinted from "Instruments and Automation", Vol. 28, No. 5, May 1055 / The Instrument Publishing Company, Inc., 1600 N. Main St., Pontiac, Ill. / 1955, printed, 12 pp., cost?

This paper surveys the various IBM punch card and electronic data-processing machines including the 650 and the 701. The explanations are written for laymen and require no technical background. The article contains many pictures and diagrams.

Wilson, E. Bright, Jr. / An Introduction to Scientific Research / McGraw-Hill Book Company, Inc., 330 West 42 St., New York 36, N. Y. / 1952, printed, 375 pp., $6.00

The preface to this book remarks that "an exploration into the unknown cannot be planned in advance with the precision of a mass-production process; nevertheless, some investigators are far more effective than others and make fewer wrong decisions at the numerous crossroads encountered in the course of a typical research problem". The book is an attempt to collect in one place and to explain as simply as possible a number of general principles, techniques, and guides for procedure which successful investigators in various fields of science have found helpful. The emphasis is on the practical rather than the philosophical. Topics have been included only if they appeared to be useful to working scientists in more than one field; consequently, the coverage tends to be broad rather than deep. Much of the material should be understandable to a college senior, but the book is more specifically intended for students beginning research and also for those more experienced research workers who wish an introduction to various topics which were not included in their training.

Nixon, Floyd E. / Principles of Automatic Controls / Prentice-Hall, Inc., 70 Fifth Ave., New York 11, N. Y. / 1953, printed, 403 pp., $9.35

Intended as a reference or as an undergraduate text, this book is concerned with all aspects of linear system design and covers transient response, frequency response, stability criteria, proper gain adjustment, the effect of noise and extraneous inputs, numerical integration, and transient analysis. Chapters 1 through 11 constitute the normal course in automatic control systems. Chapters 12 through 15 discuss further techniques and tools which the designer uses, with chapter 13 devoted to the methods of operation of automatic computers. A good background in calculus and physics is assumed. Problems are given at the end of each chapter.

Thaler, George J. / Elements of Servomechanism Theory / McGraw-Hill Book Company, Inc., New York, N. Y. / 1955, printed, 282 pp., $7.50

The material in this text is intended for a one-semester senior undergraduate course. Operational calculus and complex-variable theory are not used. Frequency-response methods are emphasized. Polar and logarithmic approaches to analysis and design are handled simultaneously. In addition to the elements of feedback control theory and the normal modern methods of applying them, the book covers loop systems and offers sufficient material on multiloop systems to introduce the problems involved and the basic approaches to solutions. The two final chapters briefly introduce advanced topics such as the root-locus method, phase plane approach, and describing functions. Problems are included.

Dooher, M. J., Editor, and 21 authors / Electronic Data Processing in Industry / American Management Association, 330 West 42 St., New York 36, N. Y. / August, 1955, printed, 256 pp., $7.75

This is a collection of papers and supplementary material prepared for the American Management Association's Special Electronics Conference, Feb. 28 to March 2, 1955. It includes information on such subjects as: how to determine whether a company should adopt electronic data-processing systems; what automatic data-processing

equipment is available; how to plan the installation of a system; how electronic data-processing equipment is being used in such fields as customer and general accounting, production planning, labor budgeting, materials handling, etc. Also included are reports of company experience with small, medium, and large computers, a summary of the evolution of data processing and its effect on company organization, and a forecast of future developments in electronics.

Horner, J. G., revised by Staton Abbey / Dictionary of Mechanical Engineering Terms / Philosophical Library, Inc., 15 E. 40 St., New York 16, N. Y. / seventh edition, 1955, printed, 538 pp., $6.50

A British dictionary of modern terms used in mechanical engineering and general and traditional terms used by draftsmen, pattern-makers, molders, boiler-makers, fitters, turners, etc. It includes vocabulary of both practical and theoretical aspects of mechanical engineering. The book is divided into two sections: Part I, "Dictionary of Modern Terms Used in Mechanical Engineering", and Part II, and Part II, "Dictionary of General and Traditional Terms Used in Mechanical Engineering".

Berthelot, R. Langlois / Electro-Magnetic Machines / Philosophical Library, Inc ; 15 East 40 St., New York 16, N. Y./ 1955, printed, 535 pp., $15.00

This book was originally published in France; the author is Chief Research Engineer for Production and Transformer Equipment at "L'Electricite de France". It contains six parts: Part I, "The Families of Electric Machines", Part 2, "General Constitution of Electrical Machines"; Part 3, "The Machines from the Designer's Standpoint"; Part 4, "The Machine from the User's Standpoint"; Part 5, "Abnormal Conditions of Operation; Part 6, "Miscellaneous General Comments". The book might be of help in analyzing and programming problems related to electrical machinery.

National Bureau of Standards / First Annual Progress Report on Applications of Electronic Data Processing Techniques to Supply Management Problems, NBS Report 3786 / U. S. Department of Commerce, National Bureau of Standards, Washington 25, D. C. / Sept. 1954, photooffset, 60 pp., limited distribution

This is a report on a development program for testing new electronic devices in applications of commercial type, by the National Bureau of Standards and the Bureau of Supplies and Accounts, Department of the Navy. The specific objectives of the project were to develop methods of applying high-speed electronic data-processing equipment to inventory control operations; in the Navy Supply System to analyze areas of applicability of electronic techniques of data-processing to supply management problems; to provide comparative tests of utilization of electronic equipment. The report is illustrated with 15 figures and 6 tables.

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FORUM

LINEAR PROGRAMMING -- REFERENCES

In the July, 1955 issue, Chandler Davis's article on Linear Programming cites the following bibliography:

1) ACTIVITY ANALYSIS OF PRODUCTION AND ALLOCATION, ed. T.C. Koopmans, Cowles Commission Monograph No. 13 (New York, 1951)

2) AN INTRODUCTION TO LINEAR PROGRAMMING, Charnes, A., Cooper, W.W. and Henderson, A., (New York, 1953).

Will you kindly tell me the names and street addresses, of the publishers of these two sources as I should like to investigate linear programming further.

Richard Storen

The publisher of both the references is John Wiley and Sons, 440 4th Ave., New York 16, N.Y.

Chandler Davis also tells us that the best bibliography on linear programming that he knows of is one published by the Linda Hall Library, Kansas City, Mo. — an unusual source.- Editor.

NEW PATENTS

RAYMOND R. SKOLNICK, Reg. Patent Agent
Ford Instrument Co., Div. of Sperry Rand Corp.
Long Island City, N.Y.

The following is a compilation of patents pertaining to computers and associated equipment from the Official Gazette of the United States Patent Office, dates of issue as indicated. Each entry consists of: patent number / inventor(s) / assignee / invention.

August 9, 1955 (continued): 2,715,206 / James W. Light, Greenville, Ohio and Howard M. Geyer, Dayton, Ohio / General Motors Corp., Detroit, Mich. / A device for controlling the synchronous operation of a plurality of rotating elements.

August 16, 1955: 2,715,274 / Hubert M. James, Belmont, Mass. / U.S.A. / An electrical computer for determining the angular position of a line of sight from a given position to a target with respect to a moving reference plane.

2,715,277 / Walter T. Lang, Brooklyn, N.Y. / Control Instrument Co., Brooklyn, N.Y. / Two-vector navigational computer.

2,715,497 / Marcel E. Droz and Raymond L. Garman, Cambridge, Mass. / U.S.A. / An electrical computer for the continuous solution in a polar coordinate reference system of the instantaneous position of a moving object in space from its horizontal and vertical velocity components.

2,715,678 / Kay H. Barney, Great Neck, N.Y. / - / A method to quantize a varying voltage to produce a reversible output in digital form.

2,715,679 / Erberto Kleissl, Milan, Italy / Fabrica Italiana Magneti Marelli Societa per Azioni, Milan, Italy / An automatic phase corrector which operates from a source of input signals.

2,715,703 / Oscar H. Schuck, Minneapolis, Minn. / Minneapolis- Honeywell Regulator Co., Minneapolis, Minn. / Remote digital controllers.

2,715,721 / Edgar William Pulsford, Strand, London, England / National Research Development Corp., London, Eng. / Integrating circuits.

2,715,721 / Eric R. Behm, Garden City, N.Y. / Control Instrument Co., Inc., Brooklyn, N.Y. / An electrical signaling apparatus adopted to compare the respective values of a reference current and a current which is variable.

2,715,722 / Matthew J. Relis, New York, N.Y. / Control Instrument Co., Brooklyn, N.Y. / A measuring apparatus adapted to compare the respective values of a variable alternating input current and another independently variable input current of the same frequency.

2,715,724 / Roelof M. M. Oberman and Antonie Snijders, The Hague, Netherlands / De Staat der Nederlanden, Directeur-General der Posterijen, Telegrafie en Telefonie, The Hague, Netherlands / A static circuit for interconverting linear voltage and binary codes.

August 23, 1955: 2,715,776 / Richard C. Knowles, New York, Carl G. Holschuk, Glen Head, and Walter T. White, Brooklyn, N.Y. / Sperry Rand Corp. / A stabilized fire control system for deriving data for properly aiming a gun to engage a fast moving target.

2,715,995 / Walter H. Wirkler, Cedar Rapids, Iowa / Collins Radio Co., Cedar Rapids, Iowa / Apparatus for computing the positions of a moving body relative to a pair of reference axes.

2,715,996 / Robert C. Avery, Jackson Heights, N.Y. / Bell Telephone Laboratories / An arrangement for counting the number of a group of objects on which a predetermined condition may exist at random.

2,715,997 / Charles M. Hill, Alameda County, Calif. / Marchant Research, Inc. / A binary adder.

2,715,998 / Lamont C. Stanley, Cedar Rapids, Iowa / Collins Radio Co., Cedar Rapids, Iowa / A method of limiting the angular motion of a counting mechanism.

2,716,156 / James S. Harris, Old Greenwich, Conn. / Radio Corp. of America / A converter for converting from a p-unit code to an n-unit code, the codes being such that there are q conditions of the p-unit code each of which defines a unit of the n-unit code.

2,716,162 / Alan R. Pearlman, Glendale, Calif. / Tracerlab Inc., Boston, Mass. / A direct current balanced amplifier.

2,716,186 / John R. Ford, Narberth, Pa. / Radio Corp. of America / A signalling system having a receiver with an indicator with at least two indicating conditions, one of danger and one of non-danger, the latter being dependent on the continual reception of signals, said system being subject to failures.

2,716,206 / Octavio M. Salati, Philadelphia, Pa. / United States of America / Assignment cancelling circuit.

2,716,208 / Francis P. Coffin Jr., Schenectady, N.Y. / U.S.A. / A long time constant servo system.

2,716,211 / Eugene A. Aas, Albuquerque, N. Mex. / U.S.A. / Thyratron trigger circuit for discharging a capacitor.

2,716,212 / Raymond U. Sims, Pittsburgh, Pa. / U.S.A. / A logarithmic discriminator.

2,716,213 / William G. Neild, Fair Haven, N.J. / Bendix Aviation Corp., Eatontown, N.J. / A stabilizing circuit for an A.C. regulator.

2,716,214 / Willis G. Wing, Roslyn Heights, N.Y. / Sperry Rand Corp. / A thermal integrator.

2,716,215 / Warren H. Flarity, Arlington, Va. / - / A method of obtaining a measure of the width of a recurrent pulse of energy of a given frequency.

2,716,220 / Wolja Saraga, Orpington, England / Telephone Manufacturing Co. Limited, England / An elementary phase shift dissipation-compensated network for producing over an extended frequency range a constant loss and a phase shift B in radians defined by the relation: $B = 2 \tan^{-1} ax$.

2,716,236 / Gloria B. Reinish, Brooklyn, and Charles E. O'Toole, Flushing, N.Y. / Sperry Rand Corp. / An apparatus for precision time interval measurement.

August 30, 1955: 2,716,520 / Donald S. Kellogg,

Great Neck, N.Y., and Russell Walker, Nutley, N.J. / W. L. Maxson Corp., New York, N.Y. / Sale price computing mechanism.

2,716,521 / William C. Brown, Ottawa, Ontario, Canada / - / A combined mechanical multiplier and divider.

2,716,732 / Brian L. Garner, Staines, England and Maurice M. Levy, Ottawa, Ontario, Canada / The General Electric Co. Limited, London, England / Apparatus for generating a pulse code signal representative of a voltage level with respect to a datum level.

September 6, 1955: 2,716,896 / Lauren F. Beldt and Dean M. Lewis, Cedar Rapids, Iowa / Collins Radio Co, Cedar Rapids, Ia. / An apparatus for limiting the rotation of a pair of shafts.

2,716,897 / Arthur H. Wulfsberg, Cedar Rapids, Iowa / Collins Radio Co., Cedar Rapids, Ia. / A differential mechanism.

2,717,120 / John C. Bellamy, Chicago, Ill. / Cook Electric Co., Chicago, Ill. / An integrating device for indicating ground position of aircraft.

2,717,310 / Thomas E. Woodruff, Los Angeles, Calif. / Hughes Aircraft Co. / An electronic integrating system for integrating a time-varying, direct-current potential.

2,717,311 / William A. Ogletree, Southampton, Pa./ Philco Corp., Philadelphia, Pa. / A simplified binary adder and multiplier circuit.

2,717,316 / Richard Madey, Berkeley, Calif. / U.S.A. / A pulse limiter and shaper circuit for a photomultiplier tube circuit.

2,717,334 / Joseph R. Desch, Dayton, Ohio / The National Cash Register Co., Dayton, Ohio / An electronic counter.

2,717,346 / Wilhelm A. Geyger, Takoma Park, Md. / U.S.A. / A magnetic servo-amplifier.

September 13, 1955: 2,717,942 / William J. Andrews, Lanchester, Pa. / U.S.A. / A continuously adjustable polyphase voltage divider resistor.

2,717,958 / Donald J. Oda, Runnemede, N.J. / Radio Corporation of America / An electrical pulse timing or delay circuit.

2,717,960 / Luis W. Alvarey, Berkeley, Calif. / U.S.A. / A circuit for producing a plurality of pulses each having a predetermined time duration separated at predetermined time intervals.

2,717,961 / Charles W. Johnstone, Garden City, N.Y. / U.S.A. / An electrical frequency division system providing limitation on the maximum output frequency.

2,717,965 / Robert A. Ramey Jr., Pittsburgh, Pa. / - / A high speed magnetic trigger circuit.

2,717,979 / Edward M. Gardiner, Seattle, Wash. / Boeing Airplane Co., Seattle, Wash. / A pattern controlled coarse-fine servomechanism.

September 20, 1955: 2,718,150 / Harold F. Elliott, Palo Alto, Calif. / - / An apparatus for selectively and precisely positioning a driven element in any of n predetermined angular positions.

2,718,355 / Edmund B. Hammond Jr., Brooklyn, and Ervin D. MacDonald, East Williston, New York / Sperry Rand Corp. / An automatic computing mechanism for a gun sight of the "own speed" type for aircraft.

2,718,356 / Warren P. Burrell and Arnold A. Cohen, Minneapolis and George A. Hardenbergh, St. Paul, Minn. / International Business Machines Corp., New York / A data conversion system.

2,718,357 / Aurelius Sandor, New York / - / A logarithmic calculator.

2,718,449 / Raymond G. Piety and Fred L. McMillan Jr., Bartlesville, Oklahoma / Phillips Petroleum Co. / An apparatus for producing pulses of electrical energy indicative of the average value of a pulsating signal voltage.

2,718,633 / Donald T. Fennessy, East Orange, N.J. / Monroe Calculating Machine Co., Orange, N.J./ A keyboard for producing serial pulses representative of decimal digits in a code wherein the representation for each odd decimal digit is the same as that for the next lower even digit plus that for the decimal digit one.

2,718,634 / Siegfried Hansen, Los Angeles, Calif. / Hughes Aircraft Co.,/ A computer system wherein digital numbers containing a plurality of digits according to a predetermined radix, are represented by constant potential signals having values proportional to the corresponding digits. A device for converting a digital number into an analog signal.

September 27, 1955: 2,719,225 / Frank A. Morris, Rochester, N.Y. / General Dynamics Corp. / An amplitude modulated signal pulse demodulator circuit.

2,719,226 / Bernard M. Gordon and Herman Lukoff, Philadelphia, Pa. / Remington Rand, Inc., New York, N.Y. / A timed signal generator

2,719,227 / Bernard M. Gordon, Philadelphia, Pa. / Sperry Rand Corp. / A counting apparatus.

2,719,228 / Isaac L. Auerbach, Philadelphia, Pa., and Stanley B. Disson, Falls Church, Va. / Burroughs Corp., Detroit, Mich. / A binary computation circuit.

2,719,250 / Willem Six, Jacobus Domburg, and Johannes T.A. van Lottum, Eindhoven, Netherlands/ Hartford National Bank and Trust Co., Hartford, Conn. / An apparatus for receiving and recording at least two series of pulses.

2,719,285 / Alexander Greenfield, Detroit, Mich./ Bendix Aviation Corp., Detroit, Mich. / An apparatus for measuring a plurality of conditions and for converting each measurement into a plurality of pulses spaced in accordance with the values of the different digits in the measurement.

October 4, 1955: 2,719,670 / Donald H. Jacobs, Wood Acres, Harold L. Shoemaker, Bethesda, and Michael May, Ashton, Md./ Donald H. Jacobs / A digital computer having a plurality of registers, each containing a number of bi-stable devices one for each denominational order in the capacity of the register, and means for determining before an addition is made whether addition of the values contained in the same denominational order of the registers will produce a carry to the next higher order.

2,719,671 / Fridthiof O.V. Larsen, Gentofte, near Copenhagen, Denmark / Aktiebolaget Duba, Stockholm, Sweden / An electrical calculating system.

2,719,940 / John C. West, Hindley, England / National Research Development Corp., London, England / A coarse-fine position-control servo system.

new digital magnetic tape transport →

the **AMPEX FR200** for digital handling provides new performance standards, new convenience features and an unmatched excellence of design

NEW EASE OF TAPE CHANGE...
The time saving feature of single loop threading is provided by a lever which moves the idlers into a straight line. This arrangement eliminates chance of faulty threading by unskilled personnel.

NEW MACHINE-TO-MACHINE TAPE COMPATIBILITY...
All Ampex FR200 Tape Transports are manufactured to exact standards that permit tapes recorded on one to be reproduced on any other. Ampex-to-Ampex compatibility is guaranteed — *and at no extra cost.*

NEW PLUG-IN HEADS TO MATCH OTHER TAPE TRANSPORTS...
The Ampex FR200 uses self aligning plug-in head assemblies. These can be furnished to match other digital or analog tape recorders to permit tape interchange. A second head stack for monitoring or "off-tape" parity checking can also be added if desired.

HIGH-SPEED START AND STOP...
On the Ampex FR200 the tape attains full speed or full stop within less than 5 milliseconds to provide high information storage density. A remote control provision is provided, as well as pushbuttons on the topplate.

NEW STANDARD OF EXCELLENCE...
The FR200 brings to digital applications the reliability, durability and adherence to specification that have made Ampex Tape Recorders the most widely used in instrumentation.

NEW LOW PRICES BEGINNING AT $2675
The base price of $2675 is for a complete FR207-TB tape transport, with 7-track head, for ½-inch tape operating at 30 ips tape speed. Prices will be quoted on machines with other tape speeds, multiple speeds, other tape widths and other heads.

FULL SPECIFICATIONS ON THE FR200 *and description of its features and accessories are given in descriptive literature. For your copy, write Dept. VV-2539*

AMPEX CORPORATION
934 CHARTER STREET
REDWOOD CITY,
CALIFORNIA

DISTRICT OFFICES: New York; Chicago; Atlanta; Dayton; Redwood City; Silver Spring, Maryland (Washington D.C. Area)
DISTRIBUTORS: Radio Shack, Boston; Bing Crosby Enterprises, Los Angeles; Southwestern Engineering & Equipment, Dallas and Houston; Ampex-American in Canada.

New Patents

October 11, 1955: 2,720,585 / James R. Deen, Hollywood, Calif. / Gilfillan Bros. Inc., Los Angeles, Calif. / A method for producing relatively long gate voltages from a series of pulses.

2,720,587 / William I.L. Wu, New York / U.S.A. / A method of converting an input signal comprising a first series of pulses of alternate polarity and varying amplitude into an output signal whose magnitude is substantially proportional to the difference in amplitude of the alternate input-signal pulses.

2,720,626 / Willis G. Wing, Roslyn Heights, N.Y./ Sperry Rand Corp. / An integrator.

October 18, 1955: 2,721,269 / Lane Wolman, Van Nuys, Calif. / Librascope, Inc., Glendale, Calif. / A damping circuit having an inductively and a capacitively reactive portion and arranged to be sharply resonant at a particular line frequency when current is supplied to said circuit from a power source.

2,721,284 / Edward M. Elmer, Santa Monica, Calif. / Summers Gyroscope Co., Santa Monica, Calif. / An integrating motor.

2,721,302 / Maurice E. Bivens and William B. Hills, Schenectady, New York / General Electric Co. / A frequency and phase converting control circuit.

2,721,308 / Maurice M. Levy, Ottawa, Ontario, Canada / General Electric Co., Limited, London, England / An apparatus for generating a pulse modulation signal from an input signal which has the means for supplying a reference level which may vary in known manner with respect to time.

2,721,318 / Ronald H. Barker, Christchurch, England / National Research Development Corp., London, England / A synchronizing arrangement for pulse code systems.

2,721,320 / Henry S. Sommers, Jr., Belmont, Mass. / U.S.A. / A signal comparison system for detecting the presence of an object by pulsed energy reflected therefrom.

October 25, 1955: 2,721,696 / Joseph D. Eisler and Elihu H. Cooley, Tulsa, Oklahoma / Stanolind Oil and Gas Co., Tulsa, Okla. / A phase equilibrium computer.

2,721,699 / William R. Baker, Berkeley, Calif. / U.S.A. / A beam current integrator.

2,721,938 / Robert B. Trousdale, Rochester, N.Y./ General Dynamics Corp. / A signal generating system for deriving, from a periodic input signal, a plurality of phase displaced signal.

2,721,990 / Joseph T. McNaney, San Diego, Calif./ General Dynamics Corp. / An apparatus for locating information in a magnetic tape.

- END -

GREETING TO COMPUTERS

In the December issue we posed a "Numble" (a number puzzle for nimble minds) -- a "greeting to computers". It was:

```
  M E R R Y
+   X M A S
-----------
= R S M E Y

  H A P P Y
+     N E W
+   Y E A R
-----------
= H R R E S
```

G E M = H E W

and: 86986 14756 94379 55431 70

Solve for the digits -- each letter stands for just one digit 0 to 9.

The solution follows: Change W to M. Y plus S ends in Y; therefore S is zero. R plus M plus zero or one carried ends in M, which is different from S; therefore one is carried and R is 9. M plus one carried is R (9); therefore M is 8. Y plus M (8) plus R (9) ends in S (0); therefore Y is 3. A plus Y (3) plus zero, one, or two carried ends in R (9) with no carry; but two cannot be carried since the most P, N, E can be is 7,6,5, since R is 9 and M is 8; therefore A is 6 or 5. R (9) plus A (6,5) plus zero carried ends in E, which is therefore 5 or 4. E (5,4) plus X plus one carried ends in S (0), and therefore is 10; so X is 9 -- minus E or 4 or 5. Both A 5 and X 5 is a contradiction. Therefore A is 6, E is 5, and X is 4. The ten digits in order 0 to 9 are S, N, P, Y, X, E, A, (G, H), (M, W), R. The numerical part of the message is (M, W), A, R(M, W), A, N, X, (G, H), E, A, R, X, Y, (G, H), R, E, E, X, Y, N, (G, H), S, which with appropriate choices is quite clearly "WARM AND HEARTY GREETINGS".

For more information about Numbles, see description of publication P 25 on page 47.

Forum

WESTERN JOINT COMPUTER CONFERENCE AND EXHIBIT FAIRMONT HOTEL, SAN FRANCISCO, FEBRUARY 7 TO 9, 1956

Tuesday, Feb. 7: Opening Addresses / Session I: Programming and Coding / II: Accessories / Cocktail Party

Wednesday, Feb. 8: III: Description and Design/ IV: Systems / Luncheon / V: Design, Programming, and Coding / VI: Applications

(continued on botton of next column)

Thursday, Feb. 9: VII: Applications / VIII: Circuits / IX: RCA Bizmac System

Notes: 35 papers including "Gestalt Programming: A New Concept in Automatic Programming" by Douglas T. Ross, Servo Lab, MIT; "An Automatic Supervisor for the IBM 702" by Bruse Moncreiff, Rand Corp.; "Unusual Problems and Their Solutions" by L. Rosenfeld, Melpar, Inc.; "Purpose and Application of the RCA Bizmac System" by W.K.Halstead and others, RCA; etc.

- END -

M A N U S C R I P T S

We are interested in articles, papers, reference information, science fiction, and discussion relating to computers and automation. To be considered for any particular issue, the manuscript should be in our hands by the fifth of the preceding month.

Articles. We desire to publish articles that are factual, useful, understandable, and interesting to many kinds of people engaged in one part or another of the field of computers and automation. In this audience are many people who have expert knowledge of some part of the field, but who are laymen in other parts of it. Consequently a writer should seek to explain his subject, and show its context and significance. He should define unfamiliar terms, or use them in a way that makes their meaning unmistakable. He should identify unfamiliar persons with a few words. He should use examples, details, comparisons, analogies, etc., whenever they may help readers to understand a difficult point. He should give data supporting his argument and evidence for his assertions. We look particularly for articles that explore ideas in the field of computers and automation, and their applications and implications. An article may certainly be controversial if the subject is discussed reasonably. Ordinarily, the length should be 1000 to 4000 words. A suggestion for an article should be submitted to us before too much work is done.

Technical Papers. Many of the foregoing requirements for articles do not necessarily apply to technical papers. Undefined technical terms, unfamiliar assumptions, mathematics, circuit diagrams, etc., may be entirely appropriate. Topics interesting probably to only a few people are acceptable.

Reference Information. We desire to print or reprint reference information: lists, rosters, abstracts, bibliographies, etc., of use to computer people. We are interested in making arrangements for systematic publication from time to time of such information, with other people besides our own staff. Anyone who would like to take the responsibility for a type of reference information should write us.

Fiction. We desire to print or reprint fiction which explores scientific ideas and possibilities about computing machinery, robots, cyber-

(continued on page 46)

PREDICTION BY COMPUTER

Bill Danch
Munich, Germany

"This thing could use over-hauling. According to it, Michigan State is tied with U.C.L.A. at half-time, 1,289,677,433 each!"

MACHINES AND RELIGION
(continued from page 9)

his standards. Such a sociological development makes us prey to the evils of conformity. It limits the possibilities of new ideas, big ideas, emerging. It may be a sign that men once again may become slaves of reality, rather than masters. This can be the evil of plenty ....that Man may lose his way just when there is a vista of a world wherein he has freed himself from most of the fetters of his body. This would indeed be a deeply tragic end for modern man.

Machines and Religion? Truly nothing could be more closely related. In the years ahead, Man's role as finder of objectives and goals to be carried out in as mechanical a way as possible will tend to make him depend upon his wits, his thinking apparatus and his philosophy more than ever before. There will be less carrying, toting, carting, typing, sorting, filing, dividing, subtracting, pressing, twisting. But there will be more thinking, deciding, communicating, selling, probing, planning, pondering, searching.

All this could develop a humanity that questions, questions to the roots of reality. Why do this; why build that city here; is it really necessary; what are we trying to achieve in the final analysis; why are we here??? Our religion of the future must be prepared for such questioners.

But also, helping, sharing, loving, feeling, inspiring -- all these still remain to the lot of Man. None of these need be one whit lessened by the advent of machines, unless we let them.

Felix Adler believed the criterion for ethical acts is that expression of personality should be made as unique and distinctive as possible. A richness of ethical relationships is the ideal. The coming era of automation can afford even greater self-expression by overcoming the enslaving inconveniences of the body in greater measure, or, -- and this is unfortunately possible -- Man may lose his way, as he did after each of his prosperous ages; he may lose his concept of his function and sink in a welter of plenty.

- END -

SPECIAL ISSUES OF "COMPUTERS AND AUTOMATION"

The issue of "Computers and Automation" in June, 1955, was a special issue: "The Computer Directory, 1955", 164 pages, containing: Part 1, Who's Who in the Computer Field; Part 2, Roster of Organizations in the Computer Field; and Part 3, The Computer Field; Products and Services for Sale.

The next Computer Directory issue will be June, 1956.

WHAT IS A COMPUTER ?

(continued from page 14)

flashed from one siding to another anywhere in the system, according to the instructions from the tower.

To find twice a number in this kind of computer, here is one typical method. The tower signals the register holding the number n, which flashes it into the calculator register A. The tower then flashes 2 into register B, and flashes "Multiply" into register Op. The Calculator then, by means of special circuits which are equivalent to a built-in digital multiplication table, doubles the number. The tower signals the Calculator what siding in Storage to send the result to, which is done, and the operation is then finished.

What is an Automatic Computer?

An automatic computer then is a computing machine that is able to operate by itself. It has an electric motor or some other source of energy. It has a program (or set of instructions) such that it is able to perform a long sequence of reasonable operations on information, with no human assistance. A modern automatic digital computer is even able to determine a large part of its own instructions by computing them too, and sending them into the Control tower.

The automatic program may of course be expressed in any one of many ways: in the wiring together of certain patch cords into certain sockets in terminal boards; in the punched holes of paper tape; in magnetized spots on magnetic tape; or in any of the forms of physical language acceptable to machines. For, any computing machine requires a language that it can deal with easily, just like a human being.

But there is really only one great simple secret -- although very many people know it by now: a machine is perfectly well able to follow out a long series of instructions, performing reasonable operations, and adjusting them according to circumstances. The application of this secret is destined to transform the world as we know it.

- END -

BULK SUBSCRIPTION RATES

These rates apply to subscriptions coming in together direct to the publisher. For example, if 5 subscriptions come in together, the saving on each one-year subscription will be 24 percent, and on each two-year subscription will be 31 percent. The bulk subscription rates, depending on the number of simultaneous subscriptions received, follow:

Table 1 -- Bulk Subscription Rates (United States)

Number of Simultaneous Subscriptions	Rate for Each Subscription, and Resulting Saving to Subscriber: One Year	Two Year
10 or more	$3.80, 31%	$6.60, 37%
5 to 9	4.20, 24	7.25, 31
4	4.60, 16	8.00, 24
3	5.00, 9	8.80, 16
2	5.25, 5	9.55, 9

For Canada, add 50 cents for each year; outside of the United States and Canada, add $1.00 for each year.

* ------------------------ * ------------------------ *

MANUSCRIPTS

(continued from page 43)

netics, automation, etc., and their implications, and which at the same time is a good story. Ordinarily, the length should be 1000 to 4000 words.

Discussion. We desire to print in "Forum" brief discussions, arguments, announcements, news, letters, descriptions of remarkable new developments, etc., anything likely to be of interest to computer people.

Payments. In many cases, we make small token payments for articles, papers, and fiction, if the author wishes to be paid. The rate is ordinarily ½¢ or 1¢ a word, the maximum is $20 or $40, and both depend on length in words, whether printed before, whether article or paper, etc.

- END -

PUBLICATIONS

P 34; LINEAR PROGRAMMING AND COMPUTERS. Reprint of two articles by Chandler Davis, in July and August 1955 "Computers and Automation". A clear, well-written introduction to linear programming, with emphasis on the ideas. $1.20

P 2D: THE COMPUTER DIRECTORY, 1955. 164 pages, 7500 Who's Who entries, 300 Organization entries, and 600 entries of Products and Services for Sale in the Computer Field; 250,000 words of condensed factual information about the computer field, June 1955 issue of "Computers and Automation." $4.00

P 32: SYMBOLIC LOGIC, by LEWIS CARROLL. Reprint of "Symbolic Logic, Part I, Elementary," 4th edition, 1847, 240 pages, by Lewis Carroll (C. L. Dodgson). Contains Lewis Carroll's inimitable and entertaining problems in symbolic logic, his method of solution (now partly out of date), and his sketches of Parts II and III, which he never wrote since he died in 1898. ....$2.50

P 25: NUMBLES -- NUMBER PUZZLES FOR NIMBLE MINDS. Report. Contains collection of puzzles like:

T R Y	H A V E	and T R A I N
+ T H E S E	F U N	your W I T S
= T W V A S	W A S E	E N T N S

WYE = VIF

In fact, you can also: 90893 85202 44393 29081 (Solve for the digits -- each letter stands for just one digit 0 to 9).
All are new numbles, additions, multiplications, etc.; some easy, some hard. Each with two messages, one open, one hidden. Hints for solution. Good exercises in logical reasoning. $1.00

MAIL
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COUPON

Edmund C. Berkeley, and Associates,
815 Washington St., R142,
Newtonville 60, Mass.

Please send me publications circled and your announcement of publications:

2D 25 32 34

I enclose $________ in full payment. (Add 10¢ per item to cover cost of handling and mailing.) It is understood that if I am not satisfied, I may return any item within five days after receiving it, and you will at once refund my money. My name and address are attached.

ROSTER ENTRY FORMS

"Computers and Automation" publishes from time to time reference information of the following three types: (1) a who's who or roster of individuals interested in the computer field; (2) a roster of organizations active in the computer field; and (3) a classified directory or roster of products and services offered in the computer field. The last cumulative editions of rosters (1) and (3) appeared in "The Computer Directory, 1955", the June 1955 issue of "Computers and Automation." The last cumulative roster (2) appeared in the December 1955 issue. If you are interested in sending information to us for these rosters and their supplements, following is the form of entry for each of these three rosters. To avoid tearing the magazine, the form may be copied on any sheet of paper.

(1) Who's Who Entry Form

1. Name (please print) ______
2. Your Address? ______
3. Your Organization? ______
4. Its Address? ______
5. Your Title? ______
6. YOUR MAIN COMPUTER INTERESTS?

( ) Applications	( ) Mathematics
( ) Business	( ) Programming
( ) Construction	( ) Sales
( ) Design	( ) Other (specify):
( ) Electronics	______
( ) Logic	______

7. Year of birth? ______
8. College or last school? ______
9. Year entered the computer field? ______
10. Occupation? ______
11. Anything else? (publications, distinctions, etc.) ______

______

(2) Organization Entry Form

1. Your organization's name? ______
2. Address? ______
3. Telephone number? ______
4. Types of computing machinery or components, or computer-field products and services that you are interested in?

______

______

5. Types of activity that you engage in:
   - ( ) research
   - ( ) manufacturing
   - ( ) selling
   - ( ) consulting
   - ( ) other (please explain): ______

______

6. Approximate number of your employees? ______
7. Year when you were established? ______
8. Any comments? ______

______

Filled in by ______

Title ______ Date ______

* ______ * ______ *

(3) Product Entry Form

1. Name or identification of product (or service)?

______

2. Brief description (20 to 40 words)? ______

______

______

______

3. How is it used? ______

______

4. What is the price range? ______
5. Under what headings should it be listed?

______

6. Your organization's name? ______

______

7. Address? ______

______

Filled in by ______

Title ______ Date ______

ROBOT SHOW STOPPERS

From time to time you may need to help organize a display in a business show including some device that you hope will "STOP" every person attending the show and make him notice your display — a device which may be called a "SHOW STOPPER".

In addition to publishing the magazine "COMPUTERS AND AUTOMATION", we have for five years been developing and constructing "ROBOT SHOW STOPPERS", small robot machines that respond to their environment and behave by themselves. Some of them are:

RELAY MOE: A machine that will play the game Tit-Tat-Toe with a human being, and either win or draw all the time, or (depending on the setting of a switch) will sometimes lose, so as to make the game more interesting for the human being;

FRANKEN: A mechanical rat that will explore a maze, find "food", and learn the path through; the maze may be set up by any person in the audience, using little partitions in any way that he wants to;

Besides these we have other small robots finished or under development. Some of these machines have been on the front covers of the magazines "Scientific American" and "Radio Electronics". These machines may be rented for shows under certain conditions; also, modifications of the small robots to fit a particular purpose are often possible, such as use of particular components, display of particular slogans, etc.

To: Berkeley Enterprises Inc.,
36 West 11 St., R142,
New York 11, N. Y.

Please send us more information about your ROBOT SHOW STOPPERS. The advertising application we have in mind is:__________

____

From: (Organization)

____

(Address)

____

(Filled in by: Name, Title, Date)

____

COMPUTERS AND AUTOMATION — Back Copies

ARTICLES, PAPERS, ETC. January, 1955: Statistics and Automatic Computers -- Gordon Spenser
Eastern Joint Computer Conference, Philadelphia, Dec. 8-10,1954 -- Milton Stoller
The Digital Differential Analyzer -- George F. Forbes
A Small High-Speed Magnetic Drum -- M. K. Taylor
An Inside-Out Magnetic Drum -- Neil Macdonald

February: Problems for Students of Computers -- John W. Carr, III
Recognizing Spoken Sounds by Means of a Computer -- Andrew D. Booth
The Significance of the New Computer NORC -- W. J. Eckert
The Finan-Seer -- E. L. Locke
Approaching Automation in a Casualty Insurance Company -- Carl O. Orkild

March: Question -- Isaac Asimov
Computers and Weather Prediction -- Bruce Gilchrist
Random Numbers and Their Generation -- Gordon Spenser
Problems Involved in the Application of Electronic Digital Computers to Business Operations -- John M. Breen
Computers to Make Administrative Decisions? -- Hans Schroeder

April: Thinking Machines and Human Personality -- Elliot L. Gruenberg
Marginal Checking -- An Aid in Preventive Maintenance of Computers -- J. Melvin Jones

May: Reliability in Electronic Data Processors -- William B. Elmore
Numerical Representation in Fixed-Point Computers -- Beatrice H. Worsley
Automation -- A Report to the UAW-CIO Economic and Collective Bargaining Conference
The Skills of the American Labor Force -- James P. Mitchell
Automation Puts Industry on Eve of Fantastic Robot Era -- A. H. Raskin
The Monkey Wrench -- Gordon R. Dickson

June: THE COMPUTER DIRECTORY, 1955 (164 pages):
Part 1: Who's Who in the Computer Field
Part 2: Roster of Organizations in the Computer Field
Part 3: The Computer Field: Products and Services for Sale.

July: Mathematics, the Schools, and the Oracle -- Alston S. Householder
The Application of Automatic Computing Equipment to Savings Bank Operations -- R. Hunt Brown
The Book Reviewer -- Rose Orente
Linear Programming and Computers, Part I -- Chandler Davis

August: The Automation of Bank Check Processing -- R. Hunt Brown
Linear Programming and Computers, Part II -- Chandler Davis
Justifying the Use of an Automatic Computer -- Ned Chapin
Charting on Automatic Data Processing Systems -- Harry Eisenpress, James L. McPherson, and Julius Shiskin
A Rotating Reading Head for Magnetic Tape and Wire -- National Bureau of Standards
Some Curiosities of Binary Arithmetic Useful in Testing Binary Computers -- Andrew D. Booth

September: A Big Inventory Problem and the IBM 702 -- Neil Macdonald
Publications for Business on Automatic Computers: A Basic Listing -- Ned Chapin
Franchise -- Isaac Asimov
Automatic Coding for Digital Computers — G. M. Hopper
Automatic Programming: The A-2 Compiler System -- Part 1

October: The Brain and Learned Behavior -- Dr. Harry F. Harlow
Automatic Programming: The A-2 Compiler System -- Part 2
Who Are Manning the New Computers? -- John M. Breen

November: Automatic Answering of Inquiries -- L. E. Griffith
Found -- A "Lost" Moon -- Dr. Paul Herget
Mister Andrew Lloyd -- R. W. Wallace

December: Digital Computers in Eastern Europe -- Alston S. Householder
Automatic Airways -- Henry T. Simmons
Roster of Organizations in the Computer Field (cumulative)

REFERENCE INFORMATION (in various issues):

Roster of Organizations in the Computer Field / Roster of Automatic Computing Services / Roster of Magazines Related to Computers and Automation / Automatic Computers: List / Automatic Computers: Estimated Commercial Population / Automatic Computing Machinery: List of Types / Components of Automatic Computing Machinery: List of Types / Products and Services in the Computer Field / Who's Who in the Computer Field / Automation: List of Outstanding Examples / Books and Other Publications / Glossary / Patents / Titles and Abstracts of Papers

BACK COPIES: Price, if available, $1.25 each, except June, 1955, $4.00. Vol. 1, no. 1, Sept. 1951, to vol. 1, no. 3, July, 1952: out of print. Vol. 1, no. 4, Oct. 1952: in print. Vol. 2, no. 1, Jan. 1953, to vol. 2, no. 9, Dec. 1953: in print except March, no. 2, and May, no. 4. Vol. 3, no. 1, Jan. 1954, to vol. 3, no. 10, Dec. 1954: in print. Vol. 4, 1955, no. 1 to 12, in print.

A subscription (see rates on page 4) may be specified to begin with the current month's or the preceding month's issue.

WRITE TO:

Berkeley Enterprises, Inc.
Publisher of COMPUTERS AND AUTOMATION
36 West 11 St., New York 11, N. Y.

ADVERTISING IN "COMPUTERS AND AUTOMATION"

Memorandum from Berkeley Enterprises, Inc.
Publisher of COMPUTERS AND AUTOMATION
36 West 11 St., New York 11, N.Y.

1. What is "COMPUTERS AND AUTOMATION"? It is a montly magazine containing articles, papers, and reference information related to computing machinery, robots, automatic control, cybernetics, automation, etc. One important piece of reference information published is the "Roster of Organizations in the Field of Computers and Automation". The basic subscription rate is $5.50 a year in the United States. Single copies are $1.25, except June, 1955, "The Computer Directory" (164 pages, $4.00). For the titles of articles and papers in recent issues of the magazine, see the "Back Copies" page in this issue.

2. What is the circulation? The circulation includes 2000 subscribers (as of Dec. 10): over 300 purchasers of individual back copies; and an estimated 2500 nonsubscribing readers. The logical readers of COMPUTERS AND AUTOMATION are people concerned with the field of computers and automation. These include a great number of people who will make recommendations to their organizations about purchasing computing machinery, similar machinery, and components, and whose decisions may involve very substantial figures. The print order for the Jan. issue was 2500 copies. The overrun is largely held for eventual sale as back copies, and in the case of several issues the overrun has been exhausted through such sale.

3. What type of advertising does COMPUTERS AND AUTOMATION take? The purpose of the magazine is to be factual and to the point. For this purpose the kind of advertising wanted is the kind that answers questions factually. We recommend for the audience that we reach, that advertising be factual, useful, interesting, understandable, and new from issue to issue. We reserve the right not to accept advertising that does not meet our standards.

4. What are the specifications and cost of advertising? COMPUTERS AND AUTOMATION is published on pages 8½" x 11" (ad size, 7" x 10") and produced by photooffset, except that printed sheet advertising may be inserted and bound in with the magazine in most cases. The closing date for any issue is approximately the 10th of the month preceding. If possible, the company advertising should produce final copy. For photooffset, the copy should be exactly as desired, actual size, and assembled, and may include typing, writing, line drawing, printing, screened half tones, and any other copy that may be put under the photooffset camera without further preparation. Unscreened photographic prints and any other copy requiring additional preparation for photooffset should be furnished separately; it will be prepared, finished, and charged to the advertiser at small additional costs. In the case of printed inserts, a sufficient quantity for the issue should be shipped to our printer, address on request.

Display advertising is sold in units of a full page (ad size 7" x 10", basic rate, $190) two-thirds page (basic rate, $145), and half page (basic rate, $97); back cover, $370; inside front or back cover, $230. Extra for color red (full pages only and only in certain positions), 35%. Two-page printed insert (one sheet), $320; four-page printed insert (two sheets), $590. Classified advertising is sold by the word (60 cents a word) with a minimum of 20 words.

5. Who are our advertisers? Our advertisers in recent issues have included the following companies, among others:

The Austin Co.
Automatic Electric Co.
Cambridge Thermionic Corp.
Federal Telephone and Radio Co.
Ferranti Electric Co.
Ferroxcube Corp. of America
General Electric Co.
Hughes Research and Development Lab.
International Business Machines Corp.
Lockheed Aircraft Corp.
Logistics Research, Inc.
Monrobot Corp.
Norden-Ketay Corp.
George A. Philbrick Researches, Inc.
Potter Instrument Co.
Raytheon Mfg. Co.
Reeves Instrument Co.
Remington Rand, Inc.
Sprague Electric Co.
Sylvania Electric Products, Inc.

ADVERTISING INDEX

The purpose of COMPUTERS AND AUTOMATION is to be factual, useful, and understandable. For this purpose, the kind of advertising we desire to publish is the kind that answers questions, such as: What are your products? What are your services: And for each product, What is it called? What does it do? How well does it work? What are its main specifications? We reserve the right not to accept advertising that does not meet our standards.

Following is the index and a summary of advertisements. Each item contains: Name and address of the advertiser / subject of the advertisement / page number where it appears / CA number in case of inquiry (see note below).

Aircraft Marine Products, Inc., 2100 Paxton St., Harrisburg, Pa. / Taper Technique / page 2 / CA No. 66

Ampex Corporation, 934 Charter St., Redwood City Calif. / Digital Magnetic Tape Transport / page 41 / CA No. 67

Arma Division, American Bosch Arma Corp., Roosevelt Field, Garden City, L. I., New York / Engineering Opportunities / page 51 / CA No. 68

Berkeley Enterprises, Inc., 36 West 11 St., New York 11, N.Y. / Publications, Robot Show Stoppers, Geniac / pages 47, 49, 53 / CA No. 69

Computers and Automation, 36 West 11 St., New York 11, N.Y. / Roster Entry Forms, Back Copies, Advertising / pages 48, 50, 52 / CA No. 70

Ferroxcube Corp., East Bridge St., Saugerties, N.Y. / Magnetic Core Materials / page 43 / CA No. 71

Hughes Research and Development Laboratories, Culver City, Calif. / Help Wanted / page 47 / CA No. 72

Lockheed Aircraft Corp., California Div., Burbank Calif. / Missile Systems Mathematics / page 5 / CA No. 73

The Glenn L. Martin Company, Baltimore 3, Md. / Simulation Engineering / page 45 / CA No. 77

Northrop Aircraft, Inc., Hawthorne, Calif. / Help Wanted / page 53 / CA No. 74

Potter Instrument Co., 115 Cutter Mill Rd., Great Neck N.Y. / Digital Magnetic and Perforated Tape Handlers / page 49 / CA No. 75

Remington Rand, Inc., 315 4th Ave., New York 10, N.Y. / Univac / page 55 / CA No. 76

Sprague Electric Co., 377 Marshall St., North Adams, Mass. / Miniature pulse transformers / page 56 / CA No. 77

Sylvania Electric Products, Inc., 175 Great Arrow Ave., Buffalo 7, N.Y. / Help Wanted / page 51 / CA No. 78

READER'S INQUIRY

If you wish more information about any products or services mentioned in one or more of these advertisements, you may circle the appropriate CA Nos. on the Reader's Inquiry Form below and send that form to us (we pay postage; see the instructions). We shall then forward your inquiries, and you will hear from the advertisers direct. If you do not wish to tear the magazine, just drop us a line on a postcard.

* ——————————— * ——————————— *

READER'S INQUIRY FORM

Paste label on envelope: ↓ Enclose form in envelope: ↓

BUSINESS REPLY LABEL
NO POSTAGE STAMP NECESSARY IF MAILED IN

4¢ Postage Will Be Paid By —

BERKELEY ENTERPRISES, INC.
36 West 11th Street
New York 11, N. Y.

FIRST CLASS
PERMIT NO 1680
Sec. 34.9, P. L. & R.
NEW YORK, N. Y.

READER'S INQUIRY FORM

Name (please print) ....

Your Address? ....

Your Organization? ....

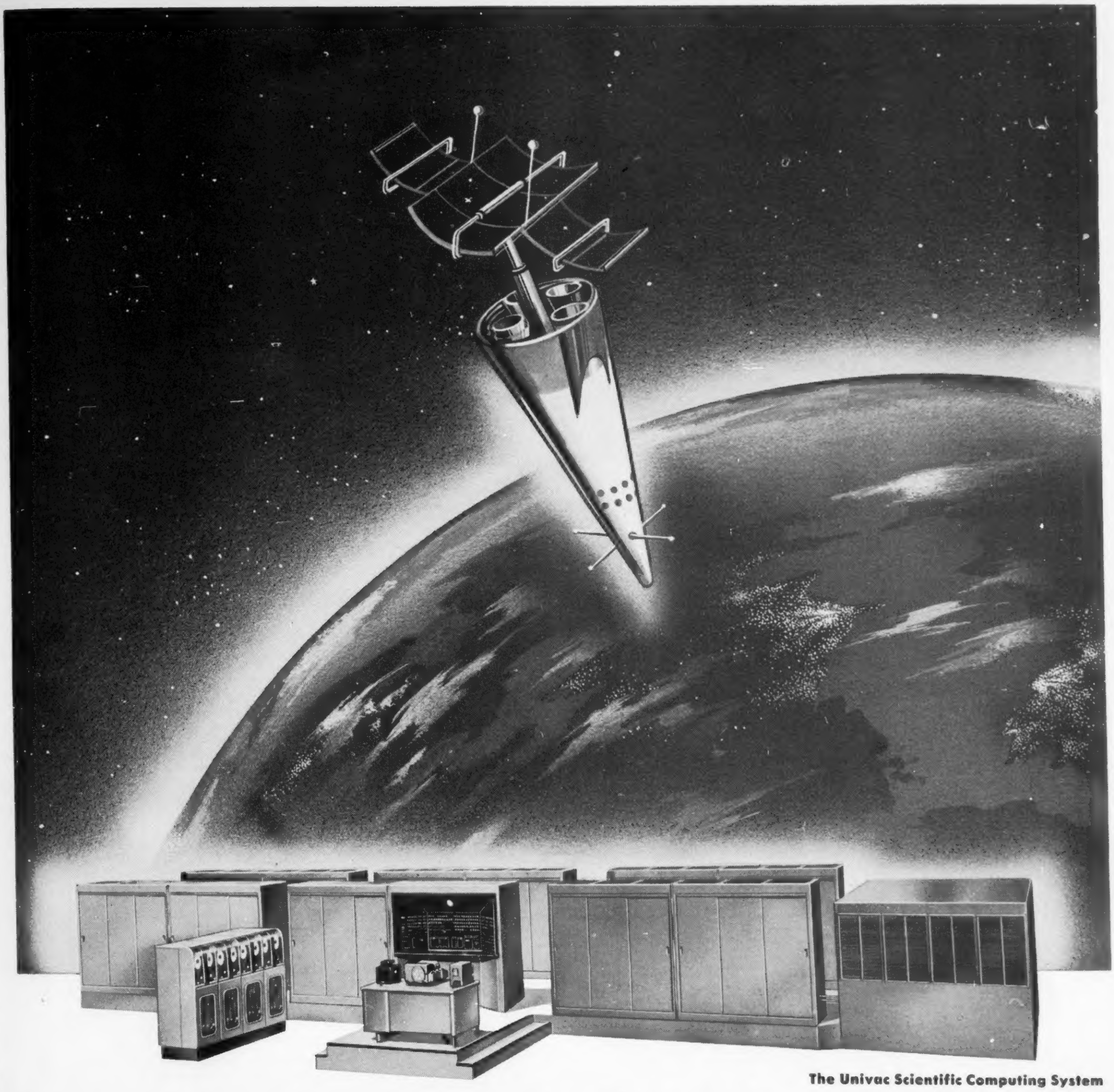
Its Address? ....

Your Title? ....

Please send me additional information on the following subjects for which I have circled the CA number:

1 2 3 4 5	26 27 28 29 30	51 52 53 54 55	76 77 78 79 80	101 102 103 104 105	126 127 128 129 130
6 7 8 9 10	31 32 33 34 35	56 57 58 59 60	81 82 83 84 85	106 107 108 109 110	131 132 133 134 135
11 12 13 14 15	36 37 38 39 40	61 62 63 64 65	86 87 88 89 90	111 112 113 114 115	136 137 138 139 140
16 17 18 19 20	41 42 43 44 45	66 67 68 69 70	91 92 93 94 95	116 117 118 119 120	141 142 143 144 145
21 22 23 24 25	46 47 48 49 50	71 72 73 74 75	96 97 98 99 100	121 122 123 124 125	146 147 148 149 150

REMARKS:



The Univac Scientific Computing System

Launching Tomorrow's Satellite

When the first man-made satellite is launched on its orbit around the earth, it will owe its existence to the thousands of missiles which have preceded it, and to the careful analysis of their patterns of flight. The Univac Scientific of Remington Rand has speeded this effort immeasurably, handling flight analyses for the nation's guided missile program.

Each missile firing, each analysis, involves enormous amounts of in-flight data, with manual computations normally requiring from 250 to 500 hours. This staggering work load is accomplished by the Univac Scientific Electronic Computer in approximately *4 to 8 minutes.*

Because of its ability to reduce large volumes of data at tremendous speeds, the Univac Scientific System easily handles even the most difficult research problems. Its speed is matched by many other outstanding characteristics, including: superb operating efficiency, obtained through large storage capacity . . . great programming versatility . . . the ability to operate simultaneously with a wide variety of input-output devices . . . and far greater reliability than any computer of its type.

For more information about the Univac Scientific System or for information about how you might apply the system to your particular problems, write on your business letterhead to . . .

ROOM 1162, 315 FOURTH AVE., NEW YORK 10

Remington Rand Univac

DIVISION OF SPERRY RAND CORPORATION

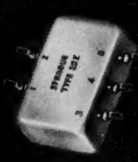
08·91 0551

choose from this complete line of

MINIATURE PULSE TRANSFORMERS

Type 10Z
tubular pulse transformer

Type 15Z
miniature bathtub pulse transformer



Type 20Z
drawn-shell bathtub pulse transformer

Type 41Z
cylindrical pulse transformer

NOW YOU CAN CHOOSE from eighteen standard pulse transformers in four major construction styles, all in quantity production at Sprague. The standard transformers covered in the table below offer a complete range of characteristics for computer circuits, blocking oscillator circuits, memory array driving circuits, etc.

These hermetically sealed units will meet such stringent military specifications as MIL-T-27, and operate at temperatures up to 85°C. Special designs are available for high acceleration and high ambient temperature operation. In addition, the electrical counterparts of each transformer can be obtained in lower cost housings designed for typical commercial environment requirements.

Complete information on this high-reliability pulse transformer line is provided in Engineering Bulletin 502A, available on letterhead request to the Technical Literature Section, Sprague Electric Company, 377 Marshall Street, North Adams, Massachusetts.

ELECTRICAL CHARACTERISTICS OF SPRAGUE PULSE TRANSFORMERS

Type No.	Turns Ratio	Pulse Width μ seconds	Rise Time μ seconds	Primary Inductance	Leakage Inductance	Repetition Rate	Load and Output	Typical Applications
10Z1	5:1	0.1	0.04	200 μH	5 μH	1 to 2 MC	15 volts 100 ohms	Used in digital computer circuitry for impedance matching and inter-stage coupling. Pulses are of sine wave type.
10Z2	4:1	0.07	0.03	200 μH	20 μH	1 to 2 MC	20 volts 100 ohms	
10Z3	1:1	0.07	0.03	125 μH	12 μH	1 to 2 MC	20 volts 200 ohms	
10Z4	3:1	0.07	0.03	160 μH	15 μH	1 to 2 MC	20 volts 100 ohms	
10Z6	4:1	0.1	0.04	200 μH	6 μH	1 to 2 MC	17 volts 100 ohms	
10Z12	1:1	0.25	0.02	200 μH	2 μH	12KC	100 volts	Blocking Oscillator
10Z13	1:1	0.33	0.07	240 μH	2 μH	2KC	50 volts	Blocking Oscillator
10Z14	7:1:1	0.50	0.05	1.2 mH	20 μH	1MC	25 volts	Impedance Matching
15Z1	3:1	5.0	0.04	7.5 mH	22 μH	10 KC	10 volts 100 ohms	Impedance Matching and Pulse Inversion
15Z2	2:1	0.5	0.07	6 mH	15 μH		40 volts	Blocking Oscillator
15Z3	5:1	10.0	0.04	12 mH	70 μH	10 KC	10 volts	Impedance Matching
15Z4	1:1.4	6.0	0.1	16 mH	15 μH	0.4 KC	15 volts	Blocking Oscillator
20Z1	5:5:1 Push-Pull	1.5	0.25	4.0 mH	0.3 MH		5 volts 10 ohms	Memory Core Current Driver
20Z3	6:1	1 to 4	0.22	18 mH	0.8 MH	250 KC (max.)	21 volts 200 ohms	Current Driver
20Z4	6:1:1	1 to 7	0.25	55 mH	0.3 MH	50 KC (max.)	22 volts 400 ohms	Current Driver and Pulse Inversion
20Z5	3.3:3.3:1 Push-Pull	2.4	0.2	2.8 mH	0.2 MH		2.5 volts 6 ohms	Memory Core Current Driver
20Z6	11:1	6.0	0.2	90 mH	0.2 MH	50 KC (max.)	10 volts 75 ohms	Current Transformer
41Z1	7:1:1	0.50	0.05	1.2 mH	20 μH	1 MC	25 volts	Impedance Matching

Sprague, on request, will provide you with complete application engineering service for optimum results in the use of pulse transformers.

SPRAGUE® WORLD'S LARGEST CAPACITOR MANUFACTURER

Export for the Americas: Sprague Electric International Ltd., North Adams, Mass. CABLE: SPREXINT

HPB-950B